THE UNIVERSITY OF
Arizona
RECORD

93-94
GRADUATE CATALOG
94-95
WHO TO CONTACT AT THE UNIVERSITY OF ARIZONA

Arizona is on Mountain Standard Time all year.

**Graduate College**
Administration Building, 3rd Floor ............................................ (602) 621-3471
Admissions ................................................................. (602) 621-3132
Degree Certification .......................................................... (602) 621-3459

**Bookstores**
ASUA Bookstore, west end of the Student Union, the UA Mall ........ (602) 621-2426

**Business Office**
Administration Building, Room 208 ........................................ (602) 621-3232

**Center for Disability Related Resources**
Second and Cherry Streets .................................................. (602) 621-3268

**Financial Aid**
Administration Building, Room 203 ....................................... (602) 621-1858

**Libraries**
Main Library, Cherry Avenue and the UA Mall ...................... (602) 621-6441
Science-Engineering Library, the UA Mall ............................ (602) 621-6384

**Registrar’s Office**
Residency Classification, Administration Building, Room 313 ... (602) 621-3636
Student Information, Administration Building, Room 210 ......... (602) 621-7809

**Residence Life (Housing)**
A.L. Slonaker Building ....................................................... (602) 621-6500

**Student Health Services**
Cherry Avenue and the UA Mall .......................................... (602) 621-6490

**Student Union**
On the UA Mall ................................................................ (602) 621-7755

**Summer Session Office**
1955 East Sixth Street ......................................................... (602) 624-UofA

**Transcripts**
Administration Building, Room 305 .................................... (602) 621-3212

**Veterans’ Services**
Student Union, Room 353 .................................................... (602) 621-6455

**Visitor Center**
Cherry Avenue and the UA Mall ........................................... (602) 621-5130
For Copies of Other University Catalogs:

General Catalog
Write: ASUA Bookstore, send a check for $4.00

College of Law Catalog
Write: The College of Law

College of Medicine Catalog
Write: The College of Medicine

Extended University Schedule or
Sierra Vista Campus Schedule
Write: Extended University

Summer Session Schedule
Write: Summer Session

For Further Information on:

Applications to the
Graduate College
Write: Graduate College Admissions

Degree Programs
Write: Head of particular department

Financial Assistance
Write: Director of Financial Aid

Housing Facilities
Write: Director of Residence Life

Medical Facilities
Write: Director of Student Health Service

Certification for Teachers
Write: Dean of College of Education

Part-Time Employment
Write: Career Services

Transcripts
Write: Office of the Registrar
Welcome to The University of Arizona

The variety and depth of the courses and curricula depicted in this catalog are a tribute to the richness of our University's graduate program, and to the extraordinary wealth of opportunity that it represents for the individual student.

Our graduate program rests on the firm foundation of a distinguished faculty and a large and ever expanding research program. These are the factors which are essential to ensuring that students are exposed to current thinking and the most recent developments in their field.

The material in this catalog can be expected to answer many of the questions that a current or potential student is likely to have. However, if you need more information, please do not hesitate to ask for help either at the Graduate College or at the individual academic department.

Sincerely,

Manuel T. Pacheco
President
All colleges and departments establish certain academic requirements which must be met before a degree is granted. These requirements concern such things as curricula and courses, majors and minors, and campus residence. Advisers, directors, department heads, and deans are available to help the student understand and arrange to meet these requirements, but the student is responsible for fulfilling them. At the end of a student’s course of study, if all requirements have not been satisfied, the degree will not be granted. For this reason it is important for each student to be acquainted and remain currently informed about all regulations and to be responsible for completing requirements. Courses, programs, and requirements described in the catalog may be suspended, deleted, restricted, supplemented, or changed in any other manner at any time at the sole discretion of the University and the Arizona Board of Regents. The catalog does not establish a contractual relationship but it summarizes the total requirements which the student must presently meet before qualifying for a faculty recommendation to the Arizona Board of Regents toward a degree.

The determination of acceptability of credit for course work completed at another institution of higher learning, whether the other institution is accredited or not, is made solely at the discretion of this institution as guided by its academic policy bodies. Students are advised to check with the Graduate Degree Certification Office to determine the acceptability of credit from other institutions and its applicability toward a program of study at the University of Arizona.

Inquiries regarding admission to the Graduate College should be addressed to:
Graduate Admissions Office
Administration 322
The University of Arizona
Tucson, AZ 85721
(602) 621-3132

Please note:
Prospective graduate students may receive a complimentary copy of The University of Arizona Graduate Catalog from the Graduate College Office. Copies may be purchased for $4.00 from the ASUA Bookstore.

The University of Arizona General Catalog may be purchased for $4.00 from the ASUA Bookstore.

Information regarding the times and locations courses are scheduled is found in the Schedule of Classes available free in the ASUA Bookstore. Schedules for fall and spring semesters are available in April and October, respectively. The Summer Session Schedule of Classes is available in February.

Credits
University Curriculum and Academic Articulation Office:
Stardust K. Johnson, Associate Director
Vera MacGregor, Program Coordinator
William Fee, Articulation Specialist

Graduate College:
Patricia A. Bailes

Biomedical Communications:
Rita Ellsworth, Designer
Margaret Hartshorn, Photographer

The address for all campus offices:
The University of Arizona
Tucson, AZ 85721

The University of Arizona Affirmative Action Statement
The University of Arizona strives to create a campus environment which understands, fosters, and embraces the value of diversity among students, faculty and staff. Diversity encompasses differences in age, color, ethnicity, gender, national origin, disability or handicap, race, religion, sexual orientation, or Vietnam-era veteran status. This institution is committed to the belief that all persons are valued for their individual characteristics, talents and contributions. Inquiries may be referred to the Office of Affirmative Action
The University of Arizona
Administration 403, Tucson, AZ 85721
(602) 621-3081
Note: For specific graduate degree completion deadlines, contact the degree certification office, Administration Building, Room 316, 621-3459.

### First Semester

<table>
<thead>
<tr>
<th>Event</th>
<th>1993-94</th>
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<tbody>
<tr>
<td>Classes begin</td>
<td>Aug. 26 Th</td>
<td>Aug. 25 Th</td>
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<tr>
<td>Last day to register for credit, to add courses and to change from no credit</td>
<td>Sept. 2 Th</td>
<td>Sept. 1 Th</td>
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<tr>
<td>Labor Day - no classes</td>
<td>Sept. 6 M</td>
<td>Sept. 5 M</td>
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<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Sept. 22 W</td>
<td>Sept. 21 W</td>
</tr>
<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Nov. 3 W</td>
<td>Nov. 2 W</td>
</tr>
<tr>
<td>Veterans' Day - no classes</td>
<td>Nov. 11 Th</td>
<td>Nov. 11 F</td>
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<tr>
<td>Thanksgiving recess</td>
<td>Nov. 25-28, Th-Su</td>
<td>Nov. 24-27, Th-Su</td>
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<tr>
<td>Class and laboratory sessions end</td>
<td>Dec. 10 F</td>
<td>Dec. 12 M</td>
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<tr>
<td>Semester examinations begin</td>
<td>Dec. 13 M</td>
<td>Dec. 14 W</td>
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<tr>
<td>Semester examinations end</td>
<td>Dec. 17 F</td>
<td>Dec. 21 W</td>
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<tr>
<td>Winter Commencement</td>
<td>Dec. 18 Sa</td>
<td>Dec. 22 Th</td>
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<td>Jan. 12 W</td>
<td>Jan. 12 Th</td>
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<tr>
<td>M.L. King Holiday - no classes</td>
<td>Jan. 17 M</td>
<td>Jan. 16 M</td>
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<tr>
<td>Last day to register for credit, to add courses and to change from no credit</td>
<td>Jan. 20 Th</td>
<td>Jan. 20 F</td>
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<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Feb. 8 Tu</td>
<td>Feb. 8 W</td>
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<tr>
<td>Spring recess</td>
<td>Mar. 12-20, Sa-Su</td>
<td>Mar. 11-19, Sa-Su</td>
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<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Mar. 29 Tu</td>
<td>Mar. 29 W</td>
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<tr>
<td>Class and laboratory sessions end</td>
<td>May 4 W</td>
<td>May 3 W</td>
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<tr>
<td>Semester examinations begin</td>
<td>May 6 F</td>
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<td>Semester examinations end</td>
<td>May 13 F</td>
<td>May 12 F</td>
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<tr>
<td>Spring Commencement</td>
<td>May 14 Sa</td>
<td>May 13 Sa</td>
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<td>Presession Classes begin</td>
<td>May 16 M</td>
<td>May 15 M</td>
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<tr>
<td>Memorial Day Holiday - no classes</td>
<td>May 30 M</td>
<td>May 29 M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>June 4 Sa</td>
<td>June 3 Sa</td>
</tr>
<tr>
<td>First Summer Session Classes begin</td>
<td>June 6 M</td>
<td>June 5 M</td>
</tr>
<tr>
<td>Independence Day</td>
<td>July 4 M</td>
<td>July 4 Tu</td>
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<tr>
<td>Last day of classes and final examination day</td>
<td>July 7 Th</td>
<td>July 6 Th</td>
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<tr>
<td>Second Summer Session Classes begin</td>
<td>July 11 M</td>
<td>July 10 M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>Aug. 10 W</td>
<td>Aug. 9 W</td>
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### ABBREVIATION GUIDE

The abbreviations listed below are used throughout this catalog to refer to the disciplines indicated.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Discipline</th>
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<tbody>
<tr>
<td>AAS</td>
<td>African-American studies</td>
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<tr>
<td>ABE</td>
<td>agricultural &amp; biosystems engineering</td>
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<tr>
<td>ACCT</td>
<td>accounting</td>
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<tr>
<td>AED</td>
<td>agricultural education</td>
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<tr>
<td>AGRI</td>
<td>agriculture</td>
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<tr>
<td>AINS</td>
<td>American Indian studies</td>
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<tr>
<td>AME</td>
<td>aerospace and mechanical engineering</td>
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<tr>
<td>ANAT</td>
<td>anatomy</td>
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<td>ANES</td>
<td>anaesthesiology</td>
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<td>C E</td>
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<td>CR L</td>
<td>critical languages</td>
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<td>ENV</td>
<td>environment and behavior</td>
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<td>FA</td>
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<td>family and consumer resources</td>
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<td>FIN</td>
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<td>French</td>
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<td>genetics</td>
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<td>geography and regional development</td>
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<td>GEOS</td>
<td>geosciences</td>
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<td>humanities</td>
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<td>HWR</td>
<td>hydrology and water resources</td>
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<td>I D</td>
<td>interior design</td>
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<td>IMED</td>
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THE UNIVERSITY—
A Brief History

In 1885—nearly three decades before Arizona became a state—the thirteenth territorial legislature approved $25,000 for building the University of Arizona in Tucson. The first classes convened in 1891, when 32 students and six teachers met in the original building now known as Old Main.

The University has developed in accordance with the Act of Congress of July 2, 1862, known as the Morrill Act. This legislation created the land-grant colleges and enabled the institution to obtain federal funds for its original schools of agriculture and mines.

In its early days, there were more students in the preparatory department than in the University proper, and the number of university graduates was never more than ten a year. Then came a decade of rapid expansion. The territory became a state, high schools multiplied, and the preparatory department was closed. In 1915, the University was reorganized as three colleges—the College of Letters, Arts, and Sciences (later Liberal Arts); the College of Mines and Engineering; and the College of Agriculture. The Arizona Bureau of Mines was established the same year.

In 1922 the College of Education was organized, and in 1925 offerings in law, originally established in 1915, were organized under the College of Law. The School of Business and Public Administration, established within the College of Letters, Arts, and Sciences in 1934, was reorganized as a separate college in 1944. In 1934 the Department of Home Economics was enlarged to a school within the College of Agriculture. In 1934 the College of Fine Arts, including the School of Music, and the Graduate School were organized independently in 1934. The Board of Regents reorganized the College of Arts and Sciences which includes the Faculty of Fine Arts, the Faculty of Humanities, the Faculty of Science, and the Faculty of Social and Behavioral Sciences. In 1984, the departments that constituted the former College of Earth Sciences were reorganized to become part of the College of Arts and Sciences and the College of Engineering, and the School of Home Economics was renamed the School of Family and Consumer Resources. In 1985, the College of Mines combined with the College of Engineering to become the College of Engineering and Mines.

The 40-acre campus of the 1890s, then some miles outside Tucson, has grown to 345 acres and 155 buildings. Its stated purpose remains: “to provide the inhabitants of this state with the means of acquiring a thorough knowledge of the various branches of literature, science, and the arts,” and, insofar as possible, to provide a technical education adapted to the development of the resources peculiar to Arizona. The university is maintained by funds appropriated by the State of Arizona and the United States government, and by fees and collections including private grants from many sources.

THE ORGANIZATION OF ACADEMIC RESPONSIBILITIES OF THE UNIVERSITY

The responsibility for administering the state’s public universities resides with the Arizona Board of Regents. The President of the University is appointed by the Arizona Board of Regents and serves as the University’s chief executive officer. The Senior Vice President for Academic Affairs and Provost is the University’s chief academic officer and the Senior Vice President for Business Affairs is the University’s chief fiscal and operations officer. Four vice presidents with responsibilities appropriate to their titles report to the Senior Vice President for Academic Affairs and Provost. They are the Vice President for Academic Services and Undergraduate Education, the Vice President for Institutional Planning, the Vice President for Research and Graduate Studies and the Vice President for Student Affairs.

Eleven colleges and four faculties comprise the academic divisions of the University. Colleges have principal responsibility for determining degree requirements, including the general education program required for each degree. The eleven colleges are the College of Agriculture, the College of Architecture, the College of Arts and Sciences, the College of Business and Public Administration, the College of Education, the College of Engineering and Mines, the College of Law, the College of Medicine, the College of Nursing, the College of Pharmacy and the Graduate College. The four faculties are divisions of the College of Arts and Sciences. They are the Faculty of Fine Arts, the Faculty of Humanities, the Faculty of Science and the Faculty of Social and Behavioral Sciences. Each college and faculty is administered by a dean who has responsibility for academic programs and policies.

Colleges and Faculties are divided into schools, departments, divisions or committees which have direct responsibility for course offerings and for determination of requirements for majors. The academic programs offered by the University through its various units are listed in the chart which follows in this section of the catalog. Course offerings are listed according to the offering department in the Departments and Courses of Instruction section of this catalog.

Graduate studies, in progress continuously since the academic year 1898-1899, were organized independently in 1934 with the founding of the Graduate College. Initially, direction was provided by a dean and a committee composed of faculty members from graduate level disciplines. Administration of the Graduate College is now provided by the Dean of the Graduate College and the Graduate Council, whose membership is broadly representative of the academic areas in which graduate programs are pursued. In addition, a Committee of Graduate Study is primarily responsible for maintaining proper standards and developing graduate programs.
ACADEMIC DIVISIONS

More detailed information may be found under listings for the specific college or department.

GRADUATE COLLEGE—Graduate Interdisciplinary Programs: American Indian Studies; Applied Mathematics; Arid Lands Resource Sciences; Biophysics; Cancer Biology; Cognitive Science; Comparative Cultural and Literary Studies; Environment and Behavior; Epidemiology; Genetics; Gerontology; History and Philosophy of Science; Latin American Studies; Medieval Studies; Neuroscience; Nutritional Sciences; Optical Sciences; Pharmacology and Toxicology; Physiological Sciences; Planning; Remote Sensing; Second Language Acquisition and Teaching.

COLLEGE OF AGRICULTURE—Schools: School of Family and Consumer Resources (with divisions in Family Studies; Merchandising and Consumer Studies; and programs in Counseling and Guidance and Interior Design); School of Renewable Natural Resources (with programs of Landscape Resources; Range Resources; Watershed Resources; Wildlife and Fisheries Resources). Departments of: Agricultural and Bio-systems Engineering; Agricultural and Resource Economics; Agricultural Education; Animal Sciences; Entomology; Nutrition and Food Science; Plant Pathology; Plant Sciences; Soil and Water Science; Undergraduate Program in Microbiology; Veterinary Science. University Departments of: Biochemistry; Molecular and Cellular Biology.

COLLEGE OF ARTS AND SCIENCES—Schools: School of Music; School of Library Science. Departments of: Anthropology; Art; Astronomy; Atmospheric Sciences; Chemistry; Classics; Communication; Computer Science; East Asian Studies; Ecology and Evolutionary Biology; English; French and Italian; Geography and Regional Development; Geosciences; German; History; Journalism; Linguistics; Mathematics; Media Arts; Near Eastern Studies; Philosophy; Physics; Planetary Sciences; Political Science; Psychology; Russian and Slavic Languages; Sociology; Spanish and Portuguese; Speech and Hearing Sciences; Statistics; Theatre Arts. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology. Committees on: African-American Studies; Critical Languages; Dance; Judaic Studies; Mexican American Studies; Religious Studies; Russian and Soviet Studies; Women's Studies. Program: Humanities.

COLLEGE OF BUSINESS AND PUBLIC ADMINISTRATION—Schools: Karl Eller Graduate School of Management; School of Public Administration and Policy. Departments of: Accounting; Economics; Finance and Real Estate; Management and Policy; Management Information Systems; Marketing.

COLLEGE OF EDUCATION—Departments of: Educational Administration and Higher Education; Educational Psychology; Language, Reading, and Culture; Special Education and Rehabilitation; and Teaching and Teacher Education.

COLLEGE OF ENGINEERING AND MINES—Departments of: Aerospace and Mechanical Engineering; Chemical Engineering; Civil Engineering and Engineering Mechanics; Electrical and Computer Engineering; Hydrology and Water Resources; Materials Science and Engineering; Mining and Geological Engineering; Nuclear and Energy Engineering; Systems and Industrial Engineering. Committee on: Biomedical Engineering.

COLLEGE OF LAW

COLLEGE OF MEDICINE—Departments of: Anatomy; Anesthesiology; Family and Community Medicine; Internal Medicine; Neurology; Obstetrics-Gynecology; Ophthalmology; Pathology; Pediatrics; Pharmacology; Physiology; Psychiatry; Radiation Oncology; Radiology; Surgery. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology.

COLLEGE OF NURSING

COLLEGE OF PHARMACY—Departments of: Pharmaceutical Sciences; Pharmacology and Toxicology; Pharmacy Practice.

SCHOOL OF HEALTH-RELATED PROFESSIONS—Department of: Exercise and Sport Sciences; Divisions of: Community and Environmental Health; Medical Technology.
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The University of Arizona is a Research 1 University and a land grant university; it belongs to the American Association of Universities; and it is ranked 18th by the National Science Foundation for its research in science and engineering. This combination makes it one of the Nation's leading universities. Graduate students total 7400 in 91 Ph.D. and 128 Masters programs. Numerous departments are ranked in the top ten nationally. The University of Arizona is especially known for its graduate interdisciplinary programs. Nineteen interdisciplinary programs offer programs at the graduate level; faculty who participate in these programs have appointments in 13 colleges and 74 departments.

THE MISSION OF THE GRADUATE COLLEGE

The mission of the Graduate College is to foster the development of high quality graduate education programs which will attract outstanding faculty, graduate students, and resources to the University. Consequently, the Graduate College provides academic leadership for scientific and scholarly research programs and programs of artistic expression throughout the University. The Graduate College provides academic support to all graduate and professional degree programs and attempts to nurture the standard-setting programs at the University of Arizona that are gaining reputations of excellence. The Graduate College is responsible for providing support services to departments and students through the Graduate Admissions Office and the Degree Certification Office and for special programs for recruiting and retaining minority graduate students.

THE NATURE OF GRADUATE WORK

Building on a well-balanced undergraduate education, graduate students are expected to develop a thorough understanding of a specific academic discipline. The fundamental purpose of the Graduate College is to encourage each graduate student to demonstrate excellent standards of scholarship and to produce high quality, original research.

The status of graduate students is different from that of undergraduates. Satisfying degree requirements should not be the primary aim of graduate students. Graduate education provides an opportunity to increase knowledge, to broaden understanding and to develop research capabilities. Consequently, the student's academic achievements should reflect a personal commitment to the discipline and to scholarly standards.

ADMISSION

Admission to the Graduate College is open to qualified applicants who hold the bachelor's degree from The University of Arizona or from a college or university which grants degrees recognized by The University of Arizona. Degrees that are recognized should be based on programs of study that meet or exceed the general education requirements for comparable majors and degrees at The University of Arizona. A degree cannot ordinarily be recognized if it is based on any of the following types of credits:

1. Credits awarded by postsecondary institutions in the United States that lack candidate status or accreditation by a regional accreditation association.
2. Credits awarded by postsecondary institutions for life experience unless validated by the institution awarding the credits through the use of standardized (such as CLEP) or comprehensive examinations.
3. Credits awarded by postsecondary institutions for courses taken at non-collegiate institutions (e.g. government agencies, corporations, industrial firms, etc.).
4. Credits awarded by postsecondary institutions for noncredit courses, workshops, and seminars offered by other postsecondary institutions as part of continuing education programs.

In general, degrees that are recognized should be based on a unit of credit comparable to that defined by the Arizona Board of Regents (26 May 1979) for institutions under its jurisdiction. A minimum of 45 hours of work by each student is required for each unit of credit. An hour of work is the equivalent of 50 minutes of class time (often called a 'contact hour') or 60 minutes of independent study work. For lecture-discussion courses, this requirement equates to at least 15 contact hours and a minimum of 30 hours of work outside of the classroom for each unit of credit. Even though the values of 15 and 30 may vary for different modes of instruction, the minimum total of 45 hours of work for each unit of credit is a constant. Each applicant with an undergraduate academic record containing "pass," "satisfactory," "credit," or similar entries for courses which have a substantial bearing on the field of specialization must also submit (i) a written evaluation by the instructor of each such course, or a letter grade, and (ii) scores on the aptitude test of the Graduate Record Examinations. Admission is granted only after approval of the applicant's previous academic record by the Dean of the Graduate College and the head of the academic unit in which the greater portion of major academic work will be completed.

Grade-Point Average

Applicants who apply for admission to the Graduate College are evaluated on the individual merits of their academic achievements and individual scholarly potential to complete graduate level course work and curriculum requirements. Ordinarily, a minimum cumulative grade-point average of 3.000 based on a 4.000 scale, over the last 60 units of course work or a minimum cumulative grade-point average of 3.000 over a minimum of 12 hours of graduate course work is required for admission to the Graduate College. Applicants should consult the academic unit to which they are applying regarding that unit's grade-point average expectations. Prospective students who do not meet this standard may enroll as nondegree students and complete 12 consecutive units of 500-level (or higher) course work with a grade-point average of at least 3.250 in order to establish eligibility for seeking admission to the graduate degree program of their choice.

Graduate Record Examination (GRE)

Normally applicants must submit scores on the Graduate Record Examination in order to complete the admission process. Scores on the aptitude test of the Graduate Record Examination are used to supplement other evidence of preparation for graduate work. Such scores are only one component of the credentials used to make admission decisions, and they are evaluated in the context of the complete record in the application folder of each applicant. No formal minimum scores on standardized examinations are required for admission to the Graduate College. A number of departments, however, have specific requirements with regard to the Graduate Record Examination, the Graduate Management Admissions Test, or other examinations. Some may require applicants to take the advanced GRE in the appropriate disci-
Graduate Nondegree Status

Individuals holding a bachelor's degree, or its equivalent, from a college or university which grants degrees recognized by The University of Arizona may attend graduate-level courses without being admitted to a graduate degree program. Such students may enroll in graduate-level course work as their qualifications and performance permit; however, no more than twelve units earned while in this status may later be requested to be applied toward an advanced degree awarded at the University.

Admission of International Students

Nonimmigrants should request graduate application forms from the Graduate Student Admissions Office and departmental requirements and materials from the major department. All international student applications, with required credentials, must reach the Graduate Student Admissions Office before February 1 for the summer and fall terms and August 1 for the spring term. International applications may apply for a deferment of their application processing fee until enrollment if they are from Hungary, Liberia, Poland, Tunisia, the territories of the former USSR or Zimbabwe. All other international applicants must submit a $35.00 processing fee with their application. Faxed documents for international applicants will be accepted for department review purposes only. An official document must be submitted before formal admission to the Graduate College will be granted. Some graduates of foreign institutions may be admitted initially as International Special Students for a period of enrollment limited to two academic terms with the understanding that they may be required to undertake some work without graduate credit in order to make up deficiencies in preparation. In any event, no commitment can be made regarding the time required to complete a course of study.

International Special Status

Students admitted to this status are full-time students, taking a minimum of nine hours of credit per semester. Those units may be in appropriate courses at either the undergraduate or graduate level. At the conclusion of the student's first semester in residence, the Graduate College and the academic unit to which the student seeks admission will evaluate the student's progress. If the academic unit recommends a change to Regular Graduate Status, the student can receive graduate credit for all graduate eligible work taken during the first semester in residence. If Regular Graduate Status is not recommended, a final evaluation of the student's progress will be conducted following the student's second semester in residence in International Special Status. Students admitted to Regular Graduate Status can receive graduate credit only for the graduate eligible units taken during the one semester immediately preceding the award of Regular Graduate Status.

Proficiency in English

The University requires all applicants whose native language is not English to take the Test of English as a Foreign Language (TOEFL) unless they have completed at least two academic years of full-time study or received a bachelor's or higher degree at a postsecondary academic institution in which English is the spoken tongue and medium of instruction. Results of the TOEFL are valid for two years and scores will be sent to The University of Arizona, when requested by the applicant, from TOEFL, Box 899-TR, Princeton, New Jersey 08540, U.S.A. The scores for this examination must be received before the student's application is complete. New students who are required to take the TOEFL and whose scores are below 550 are required to take a locally administered English test and to enroll for any further English courses which may be required by the Graduate College or by the student's department. Such courses are regarded as deficiencies and must be completed before graduation. Students whose native language is not English and who wish to be considered for a teaching assistantship must submit a TOEFL score of 550 or higher and must also submit scores on the Test of Spoken English (TSE) that is also administered by the Educational Testing Service of Princeton, New Jersey (08540), or the SPEAK test available at The University of Arizona.

For those prospective students who lack college-level English proficiency, the Center for English as a Second Language (CESL) offers full-time English language training on campus. The full semester or summer sessions carry no college credit, but satisfactory completion of CESL training meets the University's English proficiency requirement for admission. Further information can be requested from the Center for English as a Second Language, Room 104, CESL Building, University of Arizona, Tucson, AZ 85721.

Financial Resources for International Students

Students on nonimmigrant visas must certify that they possess adequate finan-
cial resources to support themselves while in residence at The University of Arizona. If sponsorship is through an organization or government agency, the sponsor must inform the Graduate Student Admissions Office, in advance, what the terms of support will be. Financial guarantees must be dated and addressed to The University of Arizona. If the University is to bill for tuition and fees, billing must be through an embassy or an agent in the United States. An official letter regarding billing information must be sent to the The University of Arizona Bursar’s Office, SUPO Box 21042, Tucson, AZ 85720. In addition, students on nonimmigrant visas are required by the University to have student accident and sickness insurance coverage for each term of enrollment. The cost of this insurance is included in the amount of financial guarantee required. Students may be exempted from The University of Arizona’s insurance plan only when their government or sponsoring agency has submitted accident and sickness insurance plans acceptable to The University of Arizona. Additional information and costs of this coverage will be sent to those international students who are accepted for admission.

Application for Admission
Application for admission to the Graduate College must be made on forms furnished by the Graduate College. New applicants should submit one set of complete official transcripts/degree certificates of all undergraduate and graduate work with the Graduate College application. Each transcript must be in its original, sealed envelope. All applications and supporting documents should be sent to the Graduate Admissions Office, University of Arizona, Administration Building, Room 322, Tucson, Arizona 85721-0001. Credits which appear as transfer credits on any other transcript are not valid; applicants must submit an official transcript from the school where the credits were earned. Applications and required credentials for domestic applicants must be submitted to the Graduate Admissions Office before August 1 for fall term and December 1 for spring term. Applicants are urged to have all materials submitted well in advance of the above dates. Submission of the application and materials up to one year in advance is recommended. Applicants whose records are not in English are required to provide a certified translation of their records. Applicants should also contact the department of their intended major to obtain departmental application materials and requirements.

Students who have been admitted to the Graduate College but who were not enrolled during the previous regular semester must reapply for admission. (See “Leave of Absence” for exception to this policy.) All material becomes the property of the Graduate College and will not be returned.

Candidacy for an Advanced Degree
Admission to graduate study does not imply admission to candidacy for an advanced degree and gives no right or claim to be so admitted. Such candidacy is determined after the student has demonstrated, by work done at The University of Arizona, the ability to do work of graduate character with originality and independence. Until admitted to candidacy a student should not rely upon taking the final examination for a degree at any set time.

Students in master's or specialist programs apply for candidacy by submitting the Master’s/Specialist Application to Candidacy, with appropriate signatures, to the Graduate College. Students in doctoral programs submit the Doctoral Application to Candidacy. Upon approval of the appropriate form by the Dean of the Graduate College, the student is admitted to candidacy.

GRADUATE CREDIT

Regular Graduate Credit Courses
Regular courses numbered at the 500, 600, 700, and 900 levels are intended for graduate students. (See the Departments and Courses of Instruction section for classification of regular courses by number.) With prior written permission of the Dean of the Graduate College, exceptionally well-qualified seniors may enroll in 500-level courses. Courses numbered at the 600, 700, and 900 levels are not open to undergraduates.

General Prerequisites for Graduate Credit in the Major
The undergraduate major, or its equivalent, in any field of study is prerequisite to graduate credit toward a major in that field. In some cases, a field of concentration in undergraduate work different but suitably related to the graduate major may be acceptable.

Deficiencies in undergraduate preparation must be satisfied by the completion of prescribed courses, for undergraduate credit.

Repeating Courses
Graduate students may not repeat for credit any course which is not marked [Rpt.] in the Graduate Catalog. For more detailed information, please see “Course Description Explanation” under Departments and Courses of Instruction elsewhere in this catalog.

Use of 400-Level Courses in Graduate Programs
A graduate student may, with the approval of his or her major and minor advisors and department heads, use up to six units of 400-level course work on the graduate degree program in areas outside of the major department or interdisciplinary program.

Graduate Credit for Seniors
A University of Arizona student of senior standing is within 15 units of completing all requirements for graduation may register for graduate work if recommended by the head of the department and approved by the Dean of the Graduate College. For such registration a petition for graduate credit in excess of senior requirements must be filed with the Dean at the time of registration. This petition must be endorsed by the professor in charge of the course and the student’s advisor. The Dean will not approve a petition unless the senior has a grade-point average of 3.000 or better on all work already completed at the University, is proceeding toward graduation as directly as possible, and does not propose a total load to exceed sixteen units. The maximum number of units of graduate credit that may be earned by a senior in any semester is equal to the difference between sixteen and the number necessary to complete requirements for graduation.

Transfer of Graduate Credit
The University of Arizona accepts graduate credit by transfer from other accredited institutions; however, the whole number of transferred units offered toward a master’s degree may not exceed twenty percent of the minimum number of units required for the degree in question. Such transfer of credit may be applied toward an advanced degree only upon satisfactory completion of such additional courses as may be prescribed by the head of the corresponding department in the University.

In any case, transfer of credit toward an advanced degree will not be made unless approved by the head of the major department, unless the grade earned was A or B, and unless it was awarded graduate credit at the institution where the work was completed. Furthermore, transfer will be made on credit only; no account will be taken of the grades of transfer work in computing the student’s...
grade-point average. Such transfer is initiated by the submission of the Application to Candidacy.

Credit for extension work from other institutions will not be accepted.

A student who plans to complete the final semester of the graduate program at another institution and to transfer those units to the graduate degree at The University of Arizona should be aware that delays in obtaining official transcripts from the other institution may result in postponing completion of degree requirements by at least one semester.

Correspondence Courses
Correspondence courses will not be accepted for graduate credit.

EXAMINATIONS AND GRADES

All courses offered for credit shall include a final examination given at the regularly scheduled examination time, unless specific exceptions for certain courses have been granted prior approval by departmental action and have been reported to the appropriate academic dean.

Grading System
The grading system used by The University of Arizona follows:

- A—Excellent
- B—Good
- C—Fair
- D—Poor
- E—Failure
- F—Failure (see “Pass/Fail Option”)
- K—Course in progress
- W—Approved withdrawal
- D—Audit
- CR—Credit

Withdrawal Grades
Prior to the end of the fourth week of classes, withdrawal from a course cancels the registration for the course. Between the end of the fourth week and the end of the tenth week, a grade of W will be awarded to students who are passing at the time of withdrawal and a grade of E will be awarded to students who are failing at the time of withdrawal. The grade of W shall not be awarded to graduate students after the last day of the tenth calendar week in which classes are held except for cause approved by the Graduate Council. The grade for a nonofficial withdrawal, without the filing of withdrawal forms, is restricted to E.

Special Grades
The grades S (superior) or P (passing) are used in place of grades A or B respectively for individual studies courses numbered 591, 593, 594, 599, 691, 693, 694, 699, 791, 793, 794, 799, 900, 908, 909, 910, 915, 920, and 925. The only grades available in courses numbered 599, 699, and 799 are S, P, C, D, E, I, and W. For courses numbered 595, 596, 695, 795, and 796, the instructor may use these special grades or the regular letter grades as departmental policy or the instructor's own policy dictates; but all registrants in a given instance are graded by the same system. Grades available for 900 are S, P, E, K, and W. The only grade available for 908, 909, 910, 915, 920, and 925 are S, P, E, K, and W. The only grade available for 930 is K. Special grades (S, P) are not used in the computation of the grade-point average.

Averaging of Grades
For the purpose of computing grade-point averages, grade points are assigned to each grade as follows: A, 4 points for each unit; B, 3 points; C, 2 points; D, 1 point; and E, 0 points. To calculate the grade-point average, the unit value for each course in which a student receives one of the above grades is multiplied by the number of grade points for that grade. The sum of these products is then divided by the sum of the units of A, B, C, D, and E. The grade-point average is based only on University credit. Although grades of D and E are included in the cumulative grade-point average, they may not be included in graduate degree programs.

Pass-Fail Option
This option is not available to graduate students except for: (a) admission deficiencies which the student has specific, prior, written approval to take on a P-F basis (only the department head or the departmental graduate advisor may give such approval, which must be on file in the Graduate College office before registration); and (b) any undergraduate, nondeficiency course available for P-F grading; and (c) any course offered by the College of Law.

Removal of Incomplete
Graduate students have a maximum of one calendar year to remove a grade of I (incomplete). This calendar year begins at the end of the semester in which the student registered for the course which was graded I (incomplete). If not removed within one calendar year, a grade of I will be changed to an E on the student's record and will be counted as an E in determining the grade-point average.

SCHOLARSHIP REQUIREMENTS

A high level of performance is expected of students enrolled in a graduate degree program. A student who does not appear to be making satisfactory progress in graduate work may be required to withdraw from the University. No student will be recommended for the award of an advanced degree unless he or she has achieved a grade-point average of 3.00 or better (a) on all work taken for graduate credit and (b) on all work included specifically in the graduate study program. To meet condition (a), the grade-point average is computed on all University of Arizona course work for which the student has enrolled for graduate credit, whether or not it is offered in satisfaction of requirements for an advanced degree, except for courses in which grades of P or S have been awarded. To meet condition (b), the grade-point average is computed in a like manner but only on courses included in an approved graduate study program. Students who do not meet condition (b) may take additional graduate course work. Such additional work may be included with the major work in the computation of the grade-point average to meet condition (b), but only with the approval of the major department secured prior to taking the work in question.

ENROLLMENT POLICIES

Full-Time Student Status
Full-time status for graduate students varies, depending upon assistantship and associateship duties and the constitution of the individual student's program. Students in doubt about their standing should consult the Graduate College.

Maximum Enrollment
The maximum enrollment (including graduate, undergraduate and audited courses) allowed per semester for students registered in the Graduate College is sixteen units.

Minimum Enrollment
Each student admitted to a graduate degree program who, during any academic term, is associated with the University in any capacity that makes use of University facilities or faculty time must register. During the fall and spring semesters, a minimum of three units of graduate credit will be required; during any summer
Supplementary Registration

Students who have previously enrolled for all the regular courses required for their degrees and who still must register shall enroll for supplementary registration (course number 930). Supplementary registration may be used concurrently with other enrollments to meet these registration requirements.

Leave of Absence

Graduate students in degree programs may, with the approval of their graduate advisor and department head, be granted a leave of absence for up to one academic year. Students on approved leave of absence will not be required to apply for readmission. Graduate students who are absent beyond the end of the approved leave of absence will be required to apply for readmission when they wish to return. The granting of a leave of absence does not extend the six-year time limitation for master's degree or the ten-year time limitation for doctoral students. "Leave of Absence" request forms are available at the Graduate College Information Desk.

Thesis and Dissertation Work in Absentia

Under conditions approved by the head of the major department or the major advisor, a portion of the student's thesis or dissertation work may be done in absentia. Approval to do work in absentia must be sought prior to undertaking the work.

Auditing of Courses by Graduate Students

With the consent of the Dean of the Graduate College and the instructors concerned, students enrolled in the Graduate College may unofficially audit courses not included in their regular programs. It is not necessary to register for such courses, but an auditor's permit must be obtained from the Dean. If courses are audited by registering as an auditor, the student's units load and the fees are the same as a registration for credit. For the purpose of reporting full- or part-time student status to outside agencies, however, only those courses taken for credit are counted. After the fourth week of classes, a change from credit to audit will be permitted only if the student is doing passing work in that course, and receives the approval of the course instructor and the Dean of the Graduate College.

GRADUATE STUDY IN SUMMER SESSIONS

Graduate study is available during The University of Arizona summer sessions.

In response to demand for graduate work during the summer, a number of departments of the University have provided for individual research in their special fields. Such courses are listed under their respective departments. Students who wish to pursue any of these courses must obtain the consent of the course instructors before registering.

Graduate credit earned at the University of Arizona Summer School at Guadalajara, Mexico, may be used directly in advanced degree programs where appropriate.

In certain departments provision is made for teachers in service and others who are unable to attend the University during the regular year to complete the requirements for the master's degree by attendance at summer sessions only.

Summer Expenses

Registration fee per unit of credit for the 1992-93 academic year was $80.00. There is an additional nonresident tuition fee for out-of-state students during Summer Session. In addition to the per unit tuition fee, students are assessed a student fee of $8.50 per unit and an Arizona Financial Aid Trust fee of $3.00. Since fees are subject to change, students should consult the current Summer Session Schedule of Classes for fees in effect for any given year.

Students engaged in academic dishonesty diminish their education and bring discredit to the academic community. Students shall not violate the Code of Academic Integrity and shall avoid situations likely to compromise academic integrity. Students shall observe the provisions of the Code whether or not faculty members establish special rules of academic integrity for particular classes. Failure of faculty to prevent cheating does not excuse students from compliance with the Code.

Faculty members shall foster an expectation of academic integrity and are responsible for notifying students of special rules of academic integrity established for a particular class (e.g., collaboration on homework, appropriate use of sources, use of the same paper in more than one class, etc.) and making every reasonable effort to avoid situations conducive to infractions of the Code.

Conduct prohibited by the Code consists of all forms of academic dishonesty, including, but not limited to: cheating, fabrication, facilitating academic dishonesty, and plagiarism as set out and defined in the Code of Conduct, modifying any academic work for the purpose of obtaining additional credit after such work has been submitted to the supervising faculty member except that the supervising faculty member may approve such alterations; failure to observe rules of academic integrity established by a faculty member for a particular course; and attempting to commit an act prohibited by this Code. Any attempt to commit an act prohibited by these rules shall be subject to sanctions to the same extent as completed acts.

Students found guilty of violating the Code are subject to any one or a combination of the following sanctions: written warning, disciplinary probation, loss of credit for the work involved, reduction in grade, failing grade assigned in the course, suspension, expulsion or other sanctions imposed by a University Hearing Board.

Sanctions that may be imposed by a faculty member are a written warning, disciplinary probation, loss of credit for the work involved, reduction in grade, and a failing grade in the course. A faculty member may recommend suspension or expulsion to a University Hearing Board.

Students charged with a violation of the Code have the right to a fair consideration of the charges including the right to see the evidence, and to confidentiality in the course of that consideration to the
extent allowed by law and fairness to other affected persons. Procedures under the Code shall be conducted privately except that a student charged with a violation of the Code shall have the right to be accompanied by an advisor in any proceeding under the Code and may cause a hearing by a University Hearing Board to be open to the public. Except in the course of authorized consideration of a charge, faculty shall not reveal the identity of students charged or otherwise involved in a violation.

For a more complete outline of procedures see the complete Code of Academic Integrity. Copies are available in the Dean of Students Office or from the Committee on Academic Integrity.

**ACCOMMODATION OF RELIGIOUS OBSERVANCE AND PRACTICE**

In accord with Board of Regents policy, no employee, agent, or policy of The University of Arizona shall discriminate against any student, employee, or other individual because of that individual’s religious belief or practice or any absence thereof. Administrators and faculty members are responsible for reasonable accommodation of individual religious practices. A refusal to accommodate is justified only when undue hardship would result from each available alternative or reasonable accommodation. Further, no administrator or faculty member shall retaliate or otherwise discriminate against any student, employee, or prospective employee because that individual has sought a religious accommodation pursuant to this policy.

Persons wishing clarification of the nature or proper application of this policy should consult the Office of the Dean of Students or the Affirmative Action Office, as appropriate.
EXPENSES, FEES AND GRADUATE APPOINTMENTS

EXPENSES AND FEES
GENERAL POLICIES

All fees are payable prior to the due date for any semester or term. Payment of fees entitles students to many services, including instruction in university courses, use of university libraries, use of laboratory and course equipment, use of the recreation center, etc. No reduction is made for students who may choose not to use some of these university services or facilities.

The University accepts Visa, MasterCard, Discover and checks for the amount due but cannot advance cash on checks. The University cannot extend credit or accept installment payments; therefore, all fees for the semester must be paid in full at the time of registration. Students with past-due debts to The University of Arizona are considered financially ineligible to register until outstanding debts are paid in full. The registration of a student whose check is returned to the bank is considered incomplete and a late fee will be assessed. Collection fees are also assessed if payment for returned checks is not received in 12 calendar days.

Fees for the 1993-94 and 1994-95 academic years were not established at the time of the publication of this catalog. Fees cited in this catalog are those which were established for the 1992-93 academic year. The Arizona Board of Regents has the legal responsibility to establish fees and reserves the right to change all fees without notice. Current registration fees are published in the Schedule of Classes for each term. Also, current information on these and other fees may be obtained from the Bursar's Office.

GENERAL FEES RELATED TO REGISTRATION

REGISTRATION AND TUITION FEES—Registration and specified fees are paid by all students enrolled at the University of Arizona; in addition, non-resident students pay tuition in lieu of the state legislative funding provided to the university through taxes paid by the state's residents. Conditions determining residency are established by Arizona state law. For a summary of those conditions and the process for determining residency status, see the section of the University of Arizona General Catalog titled Residency (Domicile) Classification for Tuition Purposes, in the chapter titled Admission and Registration, or consult the Office of Domicile Classification.

THE ARIZONA FINANCIAL AID TRUST (AFAT)—The Arizona Legislature approved a program of student aid, the Arizona Financial Aid Trust, which became effective in the 1989-90 academic year. This program was enacted through the efforts of the student governments on state campuses, the Arizona Student Association, the Arizona Board of Regents and the State Legislature. The program enables currently enrolled students in Arizona universities to receive additional financial aid and provides for the creation of a long-term endowment to assist future generations of Arizona students. As a result of the authorizing legislation and action by the Arizona Board of Regents, an Arizona Financial Aid Trust fund is assessed to all students who register for any fall, spring and summer term and is nonrefundable once class begins.

RECREATION CENTER FEE—In 1985, students adopted a referendum assessing themselves a mandatory $25 per semester fee to construct the Recreation Center. All students registering for four or more units of credit are charged the recreation center fee.

FEE FOR LATE PAYMENT OF REGISTRATION FEES—Students who don’t complete payment of all fees prior to the due date for any semester or term will be assessed a nonrefundable late fee of $25. The late fee is $50 after the 21st calendar day following the first day of class.

SPECIAL COURSE FEES AND DEPOSITS—Special course fees and deposits are applicable only under certain specific conditions and must be approved by the Provost and/or the Arizona Board of Regents. Fees for off-campus field trips, general policies, and other special campus activity fees are subject to change.

EXPENSES AND FEES PER SEMESTER FOR 1992-93 ACADEMIC YEAR

ARIZONA RESIDENTS:

<table>
<thead>
<tr>
<th>Number of Units</th>
<th>AFAT Fees</th>
<th>Recreation Center Fee</th>
<th>Registration</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$3</td>
<td>—</td>
<td>$80</td>
<td>$83</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>—</td>
<td>$160</td>
<td>$163</td>
</tr>
<tr>
<td>3</td>
<td>$3</td>
<td>—</td>
<td>$240</td>
<td>$243</td>
</tr>
<tr>
<td>4</td>
<td>$3</td>
<td>$25</td>
<td>$320</td>
<td>$348</td>
</tr>
<tr>
<td>5</td>
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<tr>
<td>6</td>
<td>$3</td>
<td>$25</td>
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<tr>
<td>7 or more</td>
<td>$6</td>
<td>$25</td>
<td>$764</td>
<td>$795</td>
</tr>
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</table>

NONRESIDENTS:

<table>
<thead>
<tr>
<th>Number of Units</th>
<th>AFAT Fees</th>
<th>Recreation Center Fee</th>
<th>Tuition &amp; Registration</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$3</td>
<td>—</td>
<td>$289</td>
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</tr>
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<td>7</td>
<td>$6</td>
<td>$25</td>
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</tr>
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<td>$6</td>
<td>$25</td>
<td>$2600</td>
<td>$2631</td>
</tr>
<tr>
<td>10</td>
<td>$6</td>
<td>$25</td>
<td>$2889</td>
<td>$2920</td>
</tr>
<tr>
<td>11</td>
<td>$6</td>
<td>$25</td>
<td>$3178</td>
<td>$3209</td>
</tr>
<tr>
<td>12 or more</td>
<td>$6</td>
<td>$25</td>
<td>$3467</td>
<td>$3498</td>
</tr>
</tbody>
</table>

‘Expenses and fees for 1993-94 were not available at the time the catalog was printed. All fees are subject to change.'
specialized equipment or facilities, private instruction, expendable materials and refundable deposits for equipment entrusted to student's care may be assessed. Special course fees are identified in the Schedule of Classes for the term in which the course is offered. See the list below for the following special fees or deposits for graduate courses approved at the time of the printing of this catalog.

**SPECIAL COURSE FEES**

<table>
<thead>
<tr>
<th>Course</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTH 642a</td>
<td>$250</td>
</tr>
<tr>
<td>ANTH 642b</td>
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<tr>
<td>ARCH 501</td>
<td>$25</td>
</tr>
<tr>
<td>ARCH 502</td>
<td>$25</td>
</tr>
<tr>
<td>ARCH 900</td>
<td>$25</td>
</tr>
<tr>
<td>ARCH 910</td>
<td>$25</td>
</tr>
<tr>
<td>ART 505</td>
<td>$10</td>
</tr>
<tr>
<td>ART 541</td>
<td>$25</td>
</tr>
<tr>
<td>ART 545</td>
<td>$25</td>
</tr>
<tr>
<td>ART 546</td>
<td>$25</td>
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<tr>
<td>ART 550</td>
<td>$40</td>
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<tr>
<td>ART 551</td>
<td>$40</td>
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<td>ART 553</td>
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<tr>
<td>ART 555</td>
<td>$40</td>
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<td>ART 556</td>
<td>$25</td>
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<td>ART 566</td>
<td>$25</td>
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<tr>
<td>ART 657</td>
<td>$25</td>
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<td>ART 659</td>
<td>$25</td>
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<td>ART 671</td>
<td>$20</td>
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<td>ART 672</td>
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<td>ART 673</td>
<td>$50</td>
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<td>ART 674</td>
<td>$40</td>
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<td>ART 675</td>
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<td>ART 676</td>
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<td>ART 677</td>
<td>$40</td>
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<tr>
<td>ART 685</td>
<td>$25</td>
</tr>
<tr>
<td>ART 686</td>
<td>$25</td>
</tr>
<tr>
<td>ART 687</td>
<td>$25</td>
</tr>
<tr>
<td>ECOL 452 (optional travel fee)</td>
<td>$250</td>
</tr>
<tr>
<td>ECOL 542</td>
<td>$250</td>
</tr>
<tr>
<td>HWR 514a</td>
<td>$60</td>
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<tr>
<td>HWR 514L</td>
<td>$25</td>
</tr>
<tr>
<td>HWR 531</td>
<td>$10</td>
</tr>
<tr>
<td>HWR 536</td>
<td>$25</td>
</tr>
<tr>
<td>HWR 550L</td>
<td>$25</td>
</tr>
<tr>
<td>MUSI Perf. Stud. (1/2 hr. wk.)</td>
<td>$40</td>
</tr>
<tr>
<td>MUSI Perf. Stud. (1 hr. week)</td>
<td>$60</td>
</tr>
<tr>
<td>WS M 561</td>
<td>$150</td>
</tr>
</tbody>
</table>

**REFUNDS OF TUITION AND FEES**

**APPLIED TO ENCUMBRANCES**—All refunds and deposits that may be due a student will be first applied to encumbrances owed the University. Refunds due will be forfeited unless called for by the last day of the semester.

**REFUND SCHEDULE**—The refund schedule begins with the first day of class and applies to weekdays (Mon.-Fri.). Sufficient time must be allowed for final clearance of registration fee payment checks before refunds will be made. Students who withdraw and who are entitled to a refund will be charged a $10 withdrawal fee. The Arizona Financial Aid Trust (AFAT) fee will not be refunded once classes begin. Students receiving financial aid will be refunded in compliance with federal regulations.

| Before semester starts | 100% |
| 1-5 days | 80% |
| 6-10 days | 60% |
| 11-15 days | 40% |
| 16-20 days | 20% |
| Thereafter | none |

**CANCELLLED REGISTRATION**—A student whose registration is cancelled because of academic failure during the preceding semester will be refunded registration fees in full. A student on the delinquent scholarship report for the first semester (failing to maintain the grade average required for his or her class and thereby automatically placed on probation) who completes registration for the second semester may, upon filing a withdrawal within two weeks of such registration, be refunded fees in full. This refund must be approved by the Registrar.

**SUMMARY OF MINIMUM ANNUAL ESTIMATED EXPENSE FOR FULL-TIME CAMPUS STUDENTS, 1992-93**

**ARIZONA RESIDENTS:**

| Registration fee | $1590.00 |
| Residence halls, average rate ($795.00 per semester) | |
| Meals in university cafeteria | $1800.00 |
| Books and supplies | $2000.00 |
| Total minimum annual expense | $6000.00 |

**NONRESIDENTS:**

| Registration fee & tuition | $6996.00 |
| Residence halls, average rate ($3498.00 per semester) | |
| Meals in university cafeteria | $2000.00 |
| Books and supplies | $6000.00 |
| Total minimum annual expense | $11,396.00 |

**MISCELLANEOUS EXPENSES:**

| Application fees to graduate degree program | $50.00 |
| Application fees to graduate nondegree status | $10.00 |
| Application fees for readmission | $10.00 |

*Graduate assistants currently on appointment are exempt from music fees in the major field if the student is a music major.

**GRADUATE APPOINTMENTS, SCHOLARSHIPS AND FINANCIAL AID**

Financial assistance for graduate students is available from diverse sources, but the primary source of information and assistance is the Office of Student Financial Aid, 203 Administration Building. A catalog delineating the financial assistance available to students is published by that office and may be obtained by requesting a copy. Various types of financial aid are described below.

Students are also urged to explore various other possibilities at other locations such as the student's major department; the College of Education; the Advisor to Study Abroad; the Student Counseling Service; and the Social Science Reference Department of the Main Library. A brochure, "Graduate College Sources of Funding for Graduate Students," is available in the Graduate College.

**Assistantships and Associateships**

Teaching and research assistantships are available in many University departments. Approximately 2,500 of these positions exist and many of them are for first-year graduate students. Salaries vary, but students may expect to receive an academic year salary in the range of $2,763 to $5,319 for services not exceeding ten hours a week, or $5,527 to $10,652 for half-time assistantships.

All communications regarding graduate assistantships and associateships should
be addressed to the head of the department concerned.

**Tuition and Fees**

Graduate assistants and associates are exempt from the nonresident tuition charge and from music fees applicable to courses in their major fields. Registration fees are not waived.

**Academic Requirement**

Graduate assistants and associates must be enrolled in a graduate degree program and must maintain a University of Arizona graduate grade-point average of 3.00 or better.

**Minimum Enrollment for Graduate Assistants and Associates**

Students employed as graduate assistants and associates are required to register for at least six units of graduate credit per semester as a condition of their appointments. Some colleges require their graduate assistants and associates to register for more than six units.

**Maximum Enrollment for Graduate Assistants and Associates**

The maximum number of units per semester which students employed as graduate assistants and associates may take is dependent upon the total hours of employment.

**Scholarships, Fellowships, Traineeships, Grants, Awards**

A limited number of scholarships and College Work Study awards are available to qualified graduate students. Interested students should request financial aid applications from the Office of Student Financial Aid. The priority deadline for applications is April 1 for continuing students and May 1 for new admits.

A limited number of Graduate Tuition Scholarships, which waive out-of-state tuition, are available for academically qualified graduate students who meet minimum GPA requirements. Scholarship recipients must be recommended by their major departments and approved by the Graduate College.

Graduate Registration Fee Scholarships, which waive the registration fee, are available in limited numbers for academically qualified graduate students. As with the Graduate Tuition Scholarships, recipients must be recommended by their major departments and approved by the Graduate College.

The Graduate College has Graduate Fellowships and Graduate Minority Fellowships for eligible students. Departments are required to apply for an allocation of these Fellowships. Departments receiving Fellowships can award them at their discretion. Students should contact their department chair for information.

The Graduate College welcomes applications from members of all ethnic groups and is especially interested in receiving materials from qualified applicants who are members of ethnic groups traditionally underrepresented in graduate programs—American Indians/Alaskan Natives, Asian/Pacific Islanders, African Americans and Hispanics.

Support offered by the Graduate College, specifically for minority students, includes: Graduate Minority Fellowships, Graduate Minority Tuition Waivers and Graduate Minority Registration Fee Scholarships (see catalog under sources of financial assistance). These awards are made at the recommendation of the student's department.

The Graduate College also supports the American Indian Graduate Student Center. Cultural activities as well as academic and support services take place at the Center. These are coordinated by a full time counselor.

The Graduate College administers several programs which are designed to provide academic, social and cultural support to minority graduate students and are funded by Arizona House Bill 2108. HB 2108 funds are targeted for Hispanic, African American, Asian/Pacific Islander and American Indian students. These programs include the Minority Graduate Student Research Fund, the Minority Graduate Student Travel Fund, a tutoring program and skill-building workshops.

Awards such as NSF Graduate Fellowships and Ford Foundation Fellowships for Minority Students are made by the sponsoring agency to individual students. Applications are submitted by students to the sponsor, usually in early fall.

**Loans**

Loan programs in which graduate students may participate include, but are not limited to, Perkins Loans (formerly National Direct Student Loans), Nursing Student Loans (NSL), Pharmacy Student Loans, Medical Student Loans, Dougherty Foundation Student Loans, and Guaranteed Student Loans.

Financial aid applications should be submitted to the Office of Student Financial Aid by the annual application deadline of the year the funds are required. The priority deadline for applications is usually May 1. Selection will be made on objective criteria with respect to the applicant's qualifications, and awards are limited by the availability of funds.

A separate application is required for the Guaranteed Student Loan Program. An applicant must be admitted to a degree program before submitting the application to the Office of Student Financial Aid. The total processing time at the University, bank and guaranty agency can take up to four months. Therefore, early application is advised.
HOUSING

Christopher City Apartments

The University of Arizona operates the Christopher City Apartments for students with families and single students, and University faculty and staff, an excellent alternative for year-round graduate students. The 360 apartments are conveniently located in northeast Tucson about a 15-minute drive from campus. Most apartments offer a breathtaking view of the nearby Santa Catalina Mountains.

The city bus system provides a direct line between campus and Christopher City that runs frequently. Bus passes are available by month or by semester at discounted rates. Recreational and educational sites are in nearby state parks. Grocery stores, postal services, a public park, a YMCA and the elementary school are some of the services located within a one and one-half mile radius of the complex. Children attend schools in Tucson Unified School District.

Christopher City is a unique and diverse community of cultures that provides family support and a peaceful environment. The complex features a state-licensed cooperative preschool for children ages 2-5. An on-site staff is available to assist residents. Ample parking, 24-hour laundry facilities, and spacious grounds are enjoyed by all residents. The community center is the focus of activities for residents and includes meeting rooms, study rooms, a weight room, a lounge/game room, and a 70-foot pool and wading pool.

All apartments are single-story with a patio and garden area. Apartments include window coverage, electric appliances and garbage disposal, and carpeting. Furnished or unfurnished apartments are available. Monthly rental rates include the cost of air conditioning, heat, and water. For current rates on the Christopher City Apartments office. Monthly rental rates include air conditioning, heat, and water. For current rates on

Housing Off the Campus

Listings of off-campus housing are available in the Center for Veterans and Off-Campus Students, Student Union 353. A renter's guide for students is available. It contains information about Tucson, utilities, apartment listings, and legal resources.

Change of Address

It is the student's responsibility to keep the University informed at all times of his or her current Tucson address. Change-of-address forms are available in the Office of Student Information, Registration and Records.

UNIVERSITY DINING SERVICE

The University offers a variety of dining services operated in the Student Union and in the Garden Court Restaurant at the Park Student Center. The range includes specialty snack bars, cafeterias, and a complete table-service restaurant. Campus vending locations are also offered. All Aboard is the university meal plan that is available to all students. For additional information, write: All Aboard, S.U.P.O. 10,000, Tucson, AZ 85720. Approximate monthly food cost for the average student is $250.00.

STUDENT UNION MAIL ROOM

The Student Union Mail Room offers a limited number of private rental mail boxes in various sizes for departments, groups, organizations, faculty, staff, and students. To rent a mail box apply at the Student Union Mail Room.

STUDENT SERVICES

Counseling, testing, job and learning skill services are available to students through the Student Resource Center in Old Main; the Student Health Service; the Speech-Language and Hearing Clinics; the Center for Disability Related Resources; the International Student Center; the American Indian Graduate Center; and the Center for Veterans and Off-Campus Students. For full information concerning each of these, the student should consult the Dean of Students Office or the General Catalog.

Student Resource Center

The Student Resource Center, located in Old Main, houses three separate departments aimed at strengthening the students' academic efforts.

The University Learning Center provides quality programs, services, and resources that are critical to the learning process and student success.

The mission of Counseling and Testing Services is to help students successfully achieve their education goals by helping them resolve personal problems that get in the way of school success, cope with and adjust to college life pressures, deal with crises that interfere with their academic performance, and learn skills to optimize their academic productivity and decision making. Counseling is free, confidential, and available to all currently-enrolled students at the University.

For further information, contact the Testing Center at (620) 621-7589.

Career Services is located in the lower level of Old Main with satellite offices in Room 229 of the College of Education and Room 210 of McClelland Hall, and offers a variety of programs designed to assist students and alumni develop and implement career plans, gain work-related experience, seek part-time work while enrolled in school and gain professional employment after graduation.

The Student Health Service

The Student Health Service helps students maintain their physical and mental health, and is a campus resource for counseling on health problems. Regularly enrolled students become eligible for care at the beginning of the semester for which registration fees have been paid. Continuing students who were registered during the spring semester but are not registered for either, or both, summer sessions may become eligible upon payment of the Optional Eligibility Fee.

Every student born after December 31, 1956, must submit proof of having been administered measles and rubella vaccines since 1980. These vaccines are available at the Student Health Center for a charge.

SERVICES—In general, the services available at the Student Health Center approximate those of the family physician. Charges are made for laboratory tests, x-ray services, physical therapy, special clinics, supplies and for prescriptions filled at the Student Health Service.
pharmacy. Charges may be paid at the Student Health Service Business Office before 5:00 p.m. on the day they are incurred or will be automatically added to your university account and must then be paid at the Bursar's Office. Visa and MasterCard are accepted. During regular school sessions, general medical care is provided; however, the Student Health Service is unable to provide all services during summer sessions, spring break and semester breaks. The Student Health Center is closed on weekends and university holidays.

Special clinics available at the Student Health Center include orthopedics, dermatology, allergy, immunization, sports medicine and minor surgery.

Chronic and pre-existing illnesses, as well as problems requiring complex therapeutic and rehabilitative care, may require outside consultation and referral to the local medical community. In such cases, the cost must be assumed by the student. Occasionally, an illness involving hazard to self or others may require temporary withdrawal from the University.

MENTAL HEALTH—The Mental Health Section of the Student Health Service is a voluntary, confidential counseling service open to all students who are eligible for care at the Student Health Service. The Mental Health Section offers skill-building workshops to promote positive, active mental health, as well as short-term individual, couple and group therapy.

HEALTH PROMOTION AND EDUCATION—Health educators and student peer educators are available for individual counseling and group presentations on sexuality, nutrition, fitness, alcohol and other drugs, and other health and wellness topics. Health Promotion also maintains a Wellness Outpost in the Student Recreation Center. Drop-in services include body composition, fitness and nutrition analysis, cholesterol screening and blood pressure checks. Stop by our lobby for a copy of the Health Enhancement Activity Schedule which lists Student Health Service support groups, skill-building workshops and classes.

INSURANCE—A supplemental health insurance plan for students is available to those regularly enrolled at the University who meet eligibility requirements. Since these requirements are subject to change, check with the Student Health Service to verify your eligibility. This insurance is not required for services at the Student Health Center. The insurance option is an HMO plan using the Student Health Service as the primary care provider for students.

MEDICAL RECORDS—The relationship between a Student Health Service clinician and a student is a personal one and professional confidence is carefully maintained. Release of information may be obtained only by specific written authorization from the student concerned.

Speech-Language and Hearing Clinics
Located in the Speech Building on the main campus, the clinics function both as a service center for persons with communication difficulties and as a training site for graduate students under supervision in the Department of Speech and Hearing Sciences. Both clinics are committed to the provision of quality and state-of-the-art services. The program is accredited by the Education Standards Board of the American Speech-Language-Hearing Association in both speech-language pathology and audiology.

The University clinics offer a full array of services to students, staff and faculty at The University of Arizona and to both children and adults in the community. The Speech-Language Clinic offers evaluation and remediation of articulation, language, voice, including abnormalities in quality, pitch, or loudness, and fluency (stuttering) disorders, as well as accent and dialect reduction. Individual and group therapy sessions are offered. Specialized instrumental testing is available. Flexible hours, including evenings, can be arranged.

Services in the Hearing Clinic include assessment of hearing; selection of hearing aids; training in use of amplification; counseling relative to alternate communication devices; as well as procurement of earmolds and maintenance of amplification systems.

For information regarding fees, consult the Speech-Language and Hearing Clinics. The clinics may be reached at 621-7070 for Hearing and 621-1826 for Speech.

Center for Disability Related Resources (CeDRR)
Through its support services, this program seeks to expand opportunities for students with disabilities to participate fully in the educational process and broader campus life. Individualized services promote independence and responsibility. Ongoing programs provide the campus and the community with opportunities for increased understanding of disabling conditions. The center is located at Second Street and Cherry Avenue (602) 621-3268 (voice or TDD).

International Student Center
The International Student Center provides specialized services to international students and scholars. These services include personal counseling and academic advising; screening and referral to academic departments and support services on campus; orientation programs each semester for newly-arriving international students; assistance in complying with federal, state, and local laws and regulations affecting non-immigrant students and scholars; liaison and support to over 40 sponsoring agencies and governments in the United States and abroad; extracurricular field trips; community interaction through the International Friends organization; co-curricular educational programs on topical international issues; and periodic workshops and seminars on topics affecting the international student and scholar population. The International Student Center is located at 915 North Tyndall Avenue. The center may be reached by telephone at (602) 621-4627 or by fax at (602) 621-4069.

American Indian Graduate Center
The American Indian Graduate Center is a support group for Indian graduate students and provides students with the opportunity to participate in social, organizational, and community activities with other graduate students and with the Indian community. Academic counseling, publishing opportunities, advocacy, financial and academic support services and meeting space are also provided.

Center for Veterans and Off-Campus Students
This center provides advocacy and programs for traditional-age commuter students, undergraduates 25 years or older (New-Traditional Students), and Veteran students. Services focus on promoting student success. Academic, social, cultural, and recreational programs are sponsored by students for students. The office is a bridge linking off-campus students to the many on-campus student service resources. Location: Student Union 353 and 350.
GENERAL REQUIREMENTS

Master's degrees may be conferred for advanced work done by students who have received the bachelor's degree from this institution or of similar standing. The master's degree implies advanced training gained through intensive study in a special field, supplemented, if advisable, by study in supporting subjects. The unit requirement varies somewhat among the various master's degrees, but all work must be completed within a six-year period. All master's degree programs must include a minimum of twelve units of work done on the University campus in Tucson. Except for a limited amount of transfer work from other approved institutions, the remaining credit requirements must be met by University credit, graduate-level courses, including (a) on-campus courses, (b) courses offered away from the main campus, and (c) approved thesis credit in absentia. For restrictions on the applicability of transfer credit to degree programs, see General Regulations (“Other Courses for Graduate Credit”). With the prior approval of the head of the department, thesis work, where applicable, may be done in absentia under the direct supervision and guidance of a member of the faculty.

Time Limitation

Graduate credit to be applicable with full value toward a master's degree shall have been earned not more than six years prior to the completion of the requirements for the degree. Graduate courses taken more than six years and not more than ten years prior to completion of degree requirements will be counted for half credit toward the degree. Work more than ten years old is not accepted toward meeting degree requirements.

Major Professor

The head of the department in which the student's major work lies shall designate as the major professor (advisor) some member of the department and, where applicable, as the thesis director either this same person or some other member of the department. To be acceptable, the student's program of study and thesis (if required) must have the prior approval of the major professor and thesis director.

Foreign Language Option

At the option of the head of the department in which the major work is done, a reading knowledge of German, French, Russian, Spanish, or other language, may be required to complete the requirements for the master's degree.

Master's Application to Candidacy

Consult the Graduate College for deadline dates by which the Master's/Specialist Application to Candidacy must be submitted to the Graduate College. This notice, approved by the major advisor and the department head on forms provided by the Graduate College, shall set forth the student's program of study and other information required by the Graduate College. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the units be offered in 500-level or above, University credit courses, and that at least one-half of the required units be offered in courses in which regular grades (A, B, C) have been earned. Approval of this notice by theDean of the Graduate College will constitute approval of advancement to candidacy for a master's degree.

Final Examination

A candidate for the master's degree must pass a final examination, oral or written or both, administered by a committee of at least three faculty members (including at least two from the major department) recommended by the major department for appointment by the Dean of the Graduate College. Deadlines for submission of final examination results may be obtained from the Degree Certification Office. Any candidate who fails the final examination may, upon recommendation of the major department and approval of the Graduate Council, be granted a second examination after a lapse of at least four months. The second examination is final.

Thesis

A thesis is required in many master's programs. The appropriate departmental statement in this catalog will indicate thesis requirements for each degree. In cases in which a thesis is part of the degree program, a limited number of thesis units (910) must be earned for its preparation. Submission of the thesis for publication by University Microfilms Incorporated is optional. Students who choose not to have their theses published by UMI will not submit copies to the Graduate College, and the theses will not be kept in the University Library. A student who elects to submit his or her thesis to University Microfilms will, following the final examination, submit to the Graduate College two complete and signed copies of the thesis (approved and accepted by the major department), along with the statement by Author and special abstract of 150 words or less. Deadlines for submission of the final thesis copies may be obtained from the Department of the Degree Certification Office. A third copy of the thesis may be required by the major department at its option. A manual describing the format of the thesis may be obtained from the Associated Students' Bookstore. A thesis fee is paid to the University Cashier to cover the cost of processing by the Graduate College and microfilming by University Microfilms.

Publication of Thesis

Master's theses are published by University Microfilms, Ann Arbor, Michigan. For the student who elects to submit his or her thesis for publication, upon certification by the student's major professor, members of the committee for the final examination, and the Graduate College, a thesis copy and an abstract of 150 words or less are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for microfilming according to specifications set forth in the thesis manual.) The manuscript is cataloged and microfilmed and the negative inspected and put in vault storage; the catalog information is sent to the Library of Congress for printing and distribution of cards for depository catalogs and libraries. The abstract is printed in Microfilm Abstracts and distributed to leading libraries in the United States and abroad, and to a selected list of journals and abstracting services. The copy is then returned to The University of Arizona Library.

Publication by microfilm does not preclude publication by other methods, and successful candidates are urged to submit thesis material for publication in a scholarly or professional journal. Suitable acknowledgment must always indicate the publication to be a thesis, or portion of a thesis, submitted in partial fulfillment of the requirements for a master's degree at The University of Arizona.
Second Master's Degree

Normally, students may earn only one master’s degree at The University of Arizona. Occasionally, a student is permitted to enter a second master’s degree program if the majors are sufficiently different to justify such an exception. No student will be permitted to undertake a third master’s degree program at the University without the specific prior approval of the Graduate Council.

MASTER OF ARTS AND MASTER OF SCIENCE

A minimum of thirty units of graduate work, including the thesis where one is appropriate, is required. Not less than fifteen units must be in a major field. By prior approval of the Graduate Council, two or more closely allied subjects may be combined to form a major. Special departmental requirements, if any, are listed under the appropriate department or committee in the Departments and Courses of Instruction section of this catalog.

MASTER OF ACCOUNTING

The Master of Accounting degree program is a graduate professional program designed to provide advanced specialized training in accounting and related fields. Except as indicated below, the general regulations and requirements for the Master of Science degree apply.

A score at the 60th percentile or above on the Graduate Management Admissions Test and an academic average of “B” or better are required for admission consideration. Applicants must also have completed 6 hours of statistics and 24 hours of accounting including: accounting principles, 6 hours; intermediate accounting, 6 hours; cost accounting, 3 hours; federal income tax, 3 hours; advanced accounting, 3 hours; and auditing, 3 hours.

Of the 30 hours required for the Master of Accounting degree, no fewer than 15 must be in the field of accounting and at least 16 must be in course work open only to graduate students.

The required courses consist of a 15-hour core: ACCT 510, 522, 535, 551 plus one from ACCT 526, 528, or 529. The balance of the 30 hours is to be completed with electives. Each candidate must pass a written comprehensive examination.

MASTER OF AGRICULTURAL EDUCATION AND MASTER OF HOME ECONOMICS EDUCATION

The general regulations and requirements for the Master of Arts and Master of Science degrees apply to these degrees, with the following exceptions. Candidates must have a bachelor’s degree and a minimum of one year’s successful classroom or extension teaching or similar education experience. Evidence of acceptability of the candidate’s experience record shall be based upon at least two letters to either the Chairperson of the Division of Family Studies or the department head in Agricultural Education from persons who have had administrative authority over the candidate’s professional work experience. These letters should attest the candidate’s professional competence. A minimum of thirty-two units of course work is required. The major or field of study shall include a minimum of twenty units in home economics education, family and consumer resources and/or education; or, agriculture and agricultural education. All candidates shall complete a professional report of approved investigative work.

MASTER OF ARCHITECTURE

The College of Architecture offers a graduate program leading to the second professional degree, the Master of Architecture. The program is designed to accommodate graduates of accredited schools of architecture and is flexible in concept in order to meet the needs and interests of students who desire advanced, specialized training in architecture and related fields.

For admission consideration, applicants must have completed, with a grade average of B or better, an undergraduate program substantially equivalent to the Bachelor of Architecture program at The University of Arizona. Students without this background will be required to complete additional undergraduate course work. Applicants must submit to the College of Architecture the following: (1) a statement of purpose for entering the graduate program, (2) a proposed program of graduate studies indicating their special interests in the field, (3) a biographical summary including a record of professional work experience, (4) a portfolio of creative work including design projects, and (5) letters from three academic and/or professional references. Students are encouraged to accumulate one year of professional work experience prior to undertaking graduate study.

This program requires a minimum of 32 graduate units including at least sixteen units of architecture. The graduate study program will be planned by the student in consultation with a committee consisting of the major professor and two additional faculty members. This program must include ARCH 596a and a thesis or master's report. The thesis and the report each consist of three parts: research, written report, and graphic presentation. Candidates must pass a final oral examination over the thesis/report and related matters.

MASTER OF BUSINESS ADMINISTRATION

The M.B.A. degree program is designed to prepare women and men for leadership and administrative positions in a wide variety of organizations. It is intended for liberal arts, engineering, science and other non-business majors, as well as for business majors.

Completion of previous business course work is not required. Prerequisites, however, include undergraduate courses in finite mathematics and calculus, which must be completed prior to enrolling in M.B.A. program course work. Students should also have a working knowledge of basic computer software packages such as word processing, spreadsheet, and database.

Admission to the program is for the fall semester only. All application materials (including Graduate Management Admission Test (GMAT) scores, two letters of recommendation, one official copy of transcripts for each college or university attended, an educational/vocational resume, brief essays on several assigned topics, and the Eller School’s supplemental application form) must be submitted to the Graduate Admissions Office in the Karl Eller Graduate School of Management in McClelland Hall 210. Interviews are not required but are highly recommended.

The Eller School of Management offers both a two-year (four semesters), full-time program and a part-time, four-year (eight
semesters and three summers) program. The 57-unit curriculum emphasizes an integrative approach to problem solving. There are ten required courses: six comprehensive business field core courses, four integrative courses (which are dual or multidisciplinary in nature), and nine elective courses. Students are also required to participate in certain professional development programs, including, but not limited to, two semesters of the MBA Guest Speakers Series. Prior to degree certification, students must complete an exit interview. The MBA Program reserves the right to change requirements for the degree.

Students who possess prior academic training equivalent to required comprehensive business field core courses may petition for a waiver of up to, but not exceeding, 15 units, thereby reducing the required units from 57 to as few as 42.

Full-time students enroll in course work in the following sequence:

**FALL I:**
- ACCT 550 (3), ECON 500 (3), MIS 567 (3), MKTG 552 (3), MKTG 500 (3)

**SPRING I:**
- ACCT 569 (3), FIN 511 (3), MAP 568 (3), MIS/ECON 570 (3), Elective (3)

**SUMMER:**
- Internship

**FALL II:**
- Electives (12)

**SPRING II:**
- Electives (12), MKTG/ECON/MAP 502 (3)

Elective areas of emphasis include: accounting, corporate finance, design of data base systems, entrepreneurship, financial institutions, health care administration, information systems design, international business, legal studies, management of information, operations management, marketing management, marketing research, quality management, and reliability and quality engineering.

**MASTER OF EDUCATION**

The M.Ed. program is designed for students who are engaged, or intend to engage, in the profession of education. Majors are available within the College of Education and in other disciplines commonly taught in the public schools or community colleges (see approved majors below).

**Majors Within the College of Education:** bilingual/multicultural education, educational administration, educational media, educational psychology, elementary education, foundations of education, higher education, reading, secondary education, and special education.

Other Approved Majors: chemistry, English, family and consumer resources, East Asian studies, French, general biology, geography, German, health education, history, journalism, mathematics, Near Eastern studies, physics, political science, Russian, Spanish, and communication. Students with any of these majors will have an advisor in the College of Education as well as in the appropriate major department. Other majors may be approved on an individual basis by the Graduate Council when specifically requested by the College of Education and the proposed major department. Applicants must meet the admission requirements of the College of Education as well as those of the proposed major department.

At the time this catalog was being edited, revisions to several of the programs in the college were being considered. All current or prospective students should check with the College of Education or the appropriate department for information regarding the status and degree requirements of all programs and degrees.

**MASTER OF FINE ARTS**

The Departments of Art, Theatre Arts, and English offer programs leading to the Master of Fine Arts degree with majors in art, theatre arts, and creative writing, respectively. Applicants must have completed appropriate undergraduate majors at this institution or one of similar standing. Deficiencies may be established if the applicant's undergraduate major differs significantly from the corresponding major at The University of Arizona. Theses are not required but the departments reserve the right to retain for departmental collections a selected work, or works, from those submitted in connection with students' work toward a degree. Final examinations are required. Applicants should contact the appropriate department for instructions about submitting examples of creative work directly to the department in support of an application. Special features and requirements of the three programs are described below.

**Major in Art**

Applicants must submit 20 slides of work, slide list, 3 letters of reference (on recommended departmental forms), resume and autobiographical statement directly to the Department of Art. Graduate College Application forms, processing fee and official transcripts, are to be sent directly to the Graduate College. No application will be considered until all the above information has been received by the department. The unit requirement for this program is 60 units, of which 12 must be in art history, art criticism or related areas, 30 in studio area of concentration, and 18 in related electives (as approved by major advisor). In lieu of a thesis, an original work, or group of such works, must be presented to the public. Review of this work will accompany the final oral examination. The exhibit may be accompanied by a written document, but the document itself will not be considered a thesis. As evidence of completion of this work, a folio of slides or photographs of the exhibition must be submitted to the Art Department graduate committee upon completion of the final examination. The candidate may be required to prepare a one-person exhibit of the work or to participate in a group exhibit during the last semester in residence.

**Major in Creative Writing**

The unit requirement for this program is 48 units. Required are six graduate literature courses in the English Department, including two literature seminars for writing students. The program also requires the writing of an original book-length work of fiction, poetry, or literary nonfiction. The rest of the program may be in writing courses, in literature, or in courses of other departments related to the student's field of interest such as playwriting, film-writing, anthropology, history, or the literature of other languages. An examination on the craft of modern literature is given at the end of the student's work. There is no foreign language requirement.

**Major in Theatre Arts**

The unit requirement for this program is sixty units. Concentrations are available in acting-directing, in design-technical production, or in dramatic writing. Applicants for the acting-directing option must submit a resume and at least three letters of recommendation and must arrange for an audition and interview. Applicants for design-technical production must submit renderings and slides or photographs of theatrical design or technical work directly to the department. Appli-
20 Requirements for Master's Degrees

The Master of Arts in library science is heavily weighted in technology and emphasizes theoretical constructs of library and information science. Competence and adaptability in managing information and in utilizing advancing technologies are key aims of the curriculum.

Admission to the Master of Arts in library science program is competitive. Admission consideration is based on: (1) a completed bachelor's degree with a well-balanced curriculum and a grade-point average of 3.0 or better on a 4-point scale; (2) competitive Graduate Record Examination aptitude test scores not more than five years old; (3) two letters of recommendation reflecting the writer's opinion of the applicant's potential as a graduate student; (4) a resume of work and educational experience. More detailed admissions application and deadline information is available from the School.

The program requires completion of a minimum of 36 units of graduate credit. Students may elect the thesis option replacing 6 units of course work. A more detailed description of the program is available from the School.

MASTER OF MUSIC

The School of Music offers programs leading to the Master of Music degree with majors in performance, composition, musicology, music education, and music theory. The programs are designed for those students whose professional and artistic goals warrant study beyond the bachelor's degree and who show continued growth in the field of music they have chosen. Applicants must have completed appropriate undergraduate majors. Deficiencies may be established if the applicant's undergraduate major differs significantly from the corresponding major at The University of Arizona.

Major in Performance

Applicants are admitted through a screening process that requires audition by personal interview or tape recording. Concentrations are offered in vocal performance, instrumental performance, conducting and accompanying. The program requires a minimum of 30 graduate units and culminates in the performance of a public recital (two recitals for accompanists).

Major in Composition

Applicants submit a minimum of three reproduced manuscript scores (with tape recordings whenever possible) for evaluation by the composition faculty. If admitted, students must complete a minimum of 30 graduate units including 12 units in advanced composition studies. An original composition is required as a thesis. A public recital of original compositions is required to complete the degree.

Major in Musicology

This major requires a minimum of 30 graduate units of which at least 12 must be in musicology. A thesis is required, as is a reading knowledge of French or German.
Major in Music Education
Applicants for master's degree programs in music education must qualify for teacher certification prior to completion of the degree. The program requires a minimum of 30 graduate units, with no more than six units of credit in special workshops. The degree culminates in a major project which demonstrates individual accomplishment of a creative, pedagogical, musical, or scholarly nature.

Major in Music Theory
This major requires a minimum of 30 graduate units of which at least 12 must be in music theory. A thesis is required.

MASTER OF PUBLIC ADMINISTRATION
The M.P.A. degree program is designed to prepare men and women for positions of administrative leadership in public sector and nonprofit organizations, as well as private organizations dealing with the public sector. Graduates may expect to pursue management or policy making concerns in a wide variety of settings within organizations at local, state, national and international levels.

The M.P.A. degree is a two-year, 54-unit program, divided into four segments of study. The first segment is a 27-unit public administration core taken by all students. The courses in this segment are:

PA 501 Public Organization Theory
PA 503 Politics and the Policy Process
ECON 500 Managerial Economics
MKTG 552 Statistical Decision Making
PA 504 Public and Policy Economics
PA 505 Methods for Policy Analysis and Program Evaluation
MAP 502 Organization Theory and Behavioral Relations
PA 507 Institutional Action
PA 508 Public and Nonprofit Financial Management

The second segment consists of 9 units in either management or policy courses. The management stream offers additional training for students wishing to pursue managerial or administrative careers. The policy stream offers additional training for those interested in careers in policy and program analysis.

The third segment is a 12-unit specialization in a substantive area of study. Specializations include health care, long-term care, criminal justice, financial management, social policy, and natural resource policy. Students with excellent first year records may design individual specializations if warranted.

Finally, a 6-unit internship is required.

For admission consideration, applicants must submit a superior undergraduate record and an acceptable score on the Graduate Record Examination or the Graduate Management Admissions Test. Applicants must be competent in basic finite mathematics and calculus. Students with a mathematics deficiency must complete M.I.S. 400 before or during the first semester of graduate study.

MASTER OF PUBLIC HEALTH
The Master of Public Health is an interdisciplinary professional degree in public health. Public health graduates apply scientific, behavioral and technical knowledge to prevent disease, disability, and premature death and to promote community health through organized community effort.

The M.P.H. degree requires a minimum of 51 credits, including a minimum of 6 and up to 12 credits of internship. For students with a Bachelor's degree and no graduate education or experience in the health field, it is expected that two years of full-time study will be needed to complete the program. For students with prior public health experience, six credits of internship may be waived with the permission of the admissions committee. Applicants for admission to the M.P.H. program who have a health related degree, or who have completed relevant graduate courses, may apply for admission with advanced standing and be allowed a maximum of 9 credits for relevant courses applicable to the M.P.H. For such advanced students, it is expected that the program may be completed in one year of full-time study.

All students will take a core of courses chosen to provide the breadth of knowledge necessary for an understanding of public health. Those who choose to concentrate in one area will then take several elective courses in that area.

The full curriculum consists of the following 51 credits:

1) Basic Principles of Epidemiology (EPI 596r) (3)
2) Biostatistics (FCM 576) (3)
3) Public Health Administration and Policy (FCM 574) (3)
4) Issues and Trends in Public Health (FCM 570) (3)
5) Environmental and Occupational Health (FCM 575) (3)
6) Biological Basis of Public Health (3)
7) Social & Behavioral Basis of Public Health (FCM 577) (3)
8) Elective courses in the area(s) of concentration (18)
9) Internship in Public Health (FCM 593a) (12)

All graduates of the M.P.H. program will have had at least two distinct experiences working in public health. Accordingly, a student entering with no previous public health experience must fulfill at least two different internship rotation requirements. A student who has prior relevant experience must carry out at least one internship rotation different from his/her previous experience.

Students may take electives in several areas or choose a particular area of concentration within one of the following: Environmental and Occupational Health, Epidemiology and Biometry, Health Administration and Policy, Health Education and Health Promotion, Community Health Care, Public Health Nutrition, Community Health Nursing, Community Health Pharmacy and International Health.

Graduate Record Exam (GRE) or Medical College Admissions Test (MCAT) scores are a required part of the application; however, this requirement is waived for those applicants with a post-baccalaureate degree. Three letters of recommendation are required for each submission as well as official copies of transcripts for each university and college attended. Brief essays on several assigned topics are also required.

MASTER OF TEACHING
The graduate programs leading to the Master of Teaching degree are intended for persons currently engaged in teaching or in other appropriate programs of training and development. The two majors available are elementary education and secondary education. At the time the catalog was being edited, revisions to the Master of Teaching program in the College of Education were being considered. All current or prospective students should check with the College of Education or the Department of Teaching and Teacher Education for information regarding the status and requirements of all programs and degrees.
REQUIREMENTS FOR SPECIALIST DEGREES

EDUCATIONAL SPECIALIST

Upon acceptance by the Graduate College, candidates for the degree of Educational Specialist are admitted by the faculty of the College of Education. The degree is granted to those who comply with the General Regulations set forth in this catalog and who satisfactorily complete the program requirements as specified by the departments offering this degree.

Admission

All prospective students should check with the appropriate department in the College of Education for information regarding the admission requirements of all programs leading to the Educational Specialist degree.

Qualifying Examination

To demonstrate acceptability to undertake work leading to candidacy for the degree, each applicant must pass a qualifying examination before or during the first term of work on an Educational Specialist program. An applicant's acceptability for work toward the degree will be judged on the basis of this examination.

Time Limitations

Requirements for the Educational Specialist degree shall be completed within a period of six calendar years after satisfactory completion of the qualifying examination. Students who are able to demonstrate to the satisfaction of the qualifying examination committee that they have kept abreast of current developments in their areas of study may have prior course work taken for graduate credit while in a graduate degree program accepted at full value to the extent this course work is relevant to the Educational Specialist program being proposed. No more than six units taken as an unclassified or nondegree graduate student, however, may be applied toward requirements for the Educational Specialist degree. If in the judgment of the examining committee, the applicant does not demonstrate possession of knowledge and concepts that prior course work would tend to suggest, relevant course work over six years old may be reduced to half credit on the proposed program of studies and such course work over ten years old may be rejected.

Advisory Committee

After successfully passing the qualifying examination, the student may request that the head of the major department appoint an advisory committee of three members from the department. With the concurrence of the head of another department, one of the committee members may be from that department. The chairperson of the committee will be the student's advisor. The duties of the committee are: (1) to evaluate the student's proposed program of study; (2) to make recommendations regarding the program to the Dean of the Graduate College through the appropriate department head, and (3) to be available to the student for advice as needed.

Program of Study

A program of study, recommended by the department head, shall be designed, in cooperation with the Advisory Council, to meet the needs of the individual student as determined by previous academic work, experience, interests, and career objectives. Please see the appropriate department in the College of Education for information on program requirements.

Final Examination

When the student has completed all course work or is in the final semester of course work and has met the required standards of scholarship, he or she shall pass a comprehensive written examination covering the graduate work. An oral examination may also be required.

Professional Experience

Except for school psychology, candidates are required to furnish evidence of a minimum of two years of successful teaching or administrative experience as approved by the department concerned, before the degree will be awarded.
DOCTOR OF PHILOSOPHY

Departments which possess special advantages for original investigation accept prospective candidates for the degree of Doctor of Philosophy. This degree requires distinguished attainment in a recognized field of learning demonstrated in a dissertation which contributes to the general fund of knowledge. It is not granted merely as a certificate of faithful performance of a prescribed program of studies and research.

Residence and Credit Requirements

The equivalent of at least six semesters of essentially full-time graduate study is required. Graduate credit earned at other approved institutions, if accepted by the major department and the Graduate Council, may be counted toward the requirements for this degree.

To meet the minimum residence requirement, the student must spend two regular semesters of essentially full-time work in the major field in actual residence at The University of Arizona, and at least thirty units of graduate credit must be completed at this institution. Any semester during which a doctoral student in actual residence at The University of Arizona is registered for at least nine units of graduate course work or research will be counted toward meeting the residence requirement, provided that the student's full time is devoted to his or her graduate work. (See next paragraph for the only exceptions to this general requirement.)

A student who proceeds directly, without a break in enrollment, from a master's degree to a doctoral degree in the same major, may be permitted to apply one or more semesters of full-time enrollment in the master's program toward the residence requirement for the doctoral degree. If there is a change of major or a break in enrollment, the residence requirement must be fulfilled again for the doctoral degree. Graduate assistants or graduate associates and students on appointment to any teaching or research position at the University can discharge the minimum residence requirement by four semesters during each of which they register for six or more units of work for graduate credit, provided their full time is devoted to their graduate work and meeting the responsibilities of their appointments.

The dissertation requires the equivalent of at least two semesters of full-time work. Registration for a minimum of eighteen units of dissertation credit (920) is required during the conduct of the dissertation. With the prior approval of the student's advisor and the head of the academic unit, dissertation work may be done in absentia.

All requirements for the degree of Doctor of Philosophy, including work done for the master's degree (if applicable), cannot exceed a period of ten years.

Major and Minor Subjects

The student shall choose a major subject and either one or two supporting minor subjects. Although the minor subject or subjects will usually be taken outside the major department, minors within the major department may be permitted with the approval of the department and the Graduate College. At least 36 units of work exclusive of the dissertation must be in the area of the major subject.

Qualifying Examination

For the purpose of demonstrating acceptability to undertake work leading to candidacy for the doctorate, each prospective candidate must pass a qualifying examination in the proposed major field. The examination is waived at the discretion of the department in a field in which the candidate has done major work toward a completed master's degree at The University of Arizona. The examination should be taken during the first semester of residence and preferably during the first two weeks of residence. Many departments also require a qualifying examination in the minor field, but this may be waived at the option of the minor department.

Program of Study

A proposed program of study recommended by the department or departments concerned must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level or above, University credit courses, and that at least one half of the required units be offered in university graduate credit courses in which regular grades (A, B, C) have been earned. (For specific degree requirements, consult the section on academic departments.)

Foreign Language Requirement

Many departments have foreign language requirements for the Ph.D. degree. Doctoral students should ascertain from the department what the foreign language requirements are, if any, and how they may be satisfied.

Preliminary Examination

Before admission to candidacy for the degree, the student must pass a general examination in the chosen fields of study. This examination is intended to test the student's general fundamental knowledge of the fields of the major and minor subjects of study. It shall include written portions covering the major and minor fields and an oral portion which shall be conducted before a committee of the faculty appointed by the Dean of the Graduate College upon consultation with the major and minor department. The written and oral portions of the preliminary examination shall take place within two successive semesters, not including summer sessions. Deadlines for the submission of paperwork pertaining to the preliminary examination are available in the Degree Certification Office. The preliminary examination will be held when essentially all course work has been completed and in any case not later than three months prior to the date of the final oral examination. No student will be permitted a second attempt to pass the preliminary examination except upon recommendation of the examining committee, endorsed by the major department and approved by the Graduate Council. The second examination, if approved, may not take place until four months from the date of the first examination. The only visitors permitted at the preliminary examination are regular University faculty members.

Advancement to Candidacy

After satisfying any language requirements, passing the preliminary examination, and showing evidence of ability to do original research, the student will submit the Doctoral Application to Candidacy to the Graduate College. Upon acceptance of this form by the Graduate College, the student will be recommended to the Graduate Council for acceptance as a candidate for the doctorate. Deadlines for the submission of paperwork pertaining to the Doctoral Application to Candidacy are available in the Degree Certification Office.
Final Examination

When the required standards of scholarship have been met and research ability has been demonstrated, the candidate shall submit to an oral examination in defense of the dissertation, as well as any general questioning which may develop therefrom related to the field of study. The exact time and place of this examination shall be scheduled with the Graduate College at least three weeks in advance and announced publicly at least one week in advance. The examination shall be open to the public. The committee shall be appointed by the Dean of the Graduate College in consultation with the major and minor departments.

Dissertation

Following the final examination, the Graduate College representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Certification Office. The candidate submits two complete and signed copies of the dissertation, along with the approval pages and special abstract, to the Graduate College for delivery to the University of Arizona Library. A processing fee must be paid to the University Cashier. The College of Education requires two additional copies of the dissertation, one for the College of Education files and one for the dissertation director. In other colleges, the major department, at its option, may require an additional copy for the departmental files. A manual of instructions relating to the form of the dissertation may be obtained from the Associated Students' Bookstore.

Publication of Dissertation

Ph.D. dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee is charged to cover this expense. Upon certification by the student's major professor, members of the committee for the final examination, and the Graduate College, a dissertation copy and an abstract of 350 words or less are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for inclusion in the dissertation and must be carefully prepared for microfilming according to specifications set forth in the Dissertation Manual.) The manuscript is cataloged and microfilmed and the negative inspected and put in vault storage; the catalog information is sent to the Library of Congress for printing and distribution of cards for depository catalogs and libraries. The abstract is printed in Microfilm Abstracts and distributed to leading libraries in the United States and abroad, and to a selected list of journals and abstracting services. The copy is then returned to the University of Arizona Library.

Publication by microfilm does not preclude publication by other means, and successful candidates are urged to submit dissertation material for publication in a scholarly or professional journal. Suitable acknowledgment must always indicate the publication to be a dissertation, or portion of a dissertation, submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Arizona.

Other Examinations

Prior to the final examination and in addition to the preliminary examination and the regularly scheduled course examinations, the candidate may be required to take any other examinations, oral or written, deemed proper by the departments concerned.

DOCTOR OF EDUCATION

Through the Graduate College, the faculty of the College of Education accepts prospective candidates for the degree of Doctor of Education. The degree is granted only to those who demonstrate a high proficiency in education and who present an approved dissertation. (For the degree of Doctor of Philosophy, see above.)

All current and prospective students should check with the College of Education or the appropriate department for information regarding the status and requirements of all programs and degrees.

Residence and Credit Requirements

The equivalent of at least six semesters of essentially full-time graduate study, including work toward a master's degree, is required. Graduate credit earned at other approved institutions, if accepted by the College of Education and the Graduate Council, may be counted toward the requirements for this degree.

To meet the minimum residence requirements, the student must spend at least two regular semesters of essentially full-time academic work in the program, beyond the master's degree, in actual residence at the University of Arizona, and at least 36 units of graduate credit must be completed at this institution. Any semester during which a doctoral student in actual residence at the University of Arizona is registered for at least nine units of graduate course work or research will be counted toward meeting the residence requirement, provided that the student's full time is devoted to his or her graduate work. (See next paragraph for the only exceptions to this general requirement.)

A student who proceeds directly, without a break in enrollment, from a master's degree to a doctoral degree in the same major, may be permitted to apply one or more semesters of full-time enrollment in the master's program toward the residence requirement for the doctoral degree. If there is a change of major or a break in enrollment, the residence requirement must be fulfilled again for the doctoral degree. Graduate assistants or graduate associates and students on appointment to any teaching or research position at the University can discharge the minimum residence requirement by four semesters during each of which they register for six or more units of work for graduate credit, provided their full time is devoted to their graduate work and meeting the responsibilities of their appointments.

The dissertation requires the equivalent of at least two semesters of full-time work. Registration for a minimum of eighteen units of dissertation credit (920) is required during the conduct of the dissertation, with a maximum of nine units during any regular semester. With the prior approval of the student's advisor and the head of the academic unit, dissertation work may be done in absentia.

All requirements for the degree of Doctor of Education, including work done for the master's degree (if applicable), cannot exceed a period of ten years.

Major and Minor Subjects

The student will major in educational administration; language, reading and culture; special education and rehabilitation; and teaching and teacher education. The student may minor either inside or outside the College of Education as approved by the advisors and department heads concerned and by the Graduate Council.

Qualifying Examination

To demonstrate acceptability to undertake work leading to candidacy for the doctorate, each applicant must pass a
qualifying examination in the major field and in the proposed minor field. This examination must be taken in the first term of work beyond the master’s degree during which the student is in residence at the University of Arizona. The applicant’s acceptability for doctoral work will be judged on the basis of this examination. A qualifying examination in the minor field may be waived at the option of the department concerned.

Program of Study
A proposed program of study recommended by the department or departments concerned must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the units be offered in 500-level or above, University credit courses, and that at least one half of the required units be offered in university graduate credit courses in which regular grades (A, B, C) have been earned. (For specific degree requirements, consult the section on academic departments.)

Preliminary Examination
Before admission to candidacy for the degree, the student must pass a general examination in the chosen fields of study. This examination is intended to test the student’s general fundamental knowledge of the fields of the major and minor subjects of study. It shall include written portions covering the major and minor fields and an oral portion which shall be conducted before a committee of the faculty appointed by the Dean of the Graduate College upon consultation with the major and minor academic units. The written and oral portions of the preliminary examination shall take place within two successive semesters, not including summer sessions. No later than three weeks prior to the proposed date of the examination, the Request to Schedule Preliminary Oral Examination must be filed with the Graduate College. The preliminary examination will be held when essentially all course work has been completed and in any case not later than three months prior to the date of the final oral examination. No student will be permitted a second attempt to pass the preliminary examination except upon recommendation of the examining committee, endorsed by the major department and approved by the Graduate Council. The second examination, if approved, may not take place until four months after the date of the first examination. The only visitors permitted at the preliminary examination are regular University faculty members.

Advancement to Candidacy
After passing the preliminary examination and giving evidence of ability to carry on professional studies at the highest level, the student will be recommended to the Graduate Council for acceptance as a candidate for the doctorate.

Final Examination
When the required standards of scholarship have been met and research ability has been demonstrated, the candidate shall submit to an oral examination in defense of the dissertation, as well as any general questioning related to his or her field of study which may develop therefrom. The exact time and place of this examination shall be announced to the Graduate College no later than three weeks in advance and announced publicly at least one week in advance. The examination shall be open to the public. The committee shall be appointed by the Dean of the Graduate College in consultation with the major and minor departments.

Dissertation
Following the examination, the Graduate College representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Check Office. The candidate submits two complete and signed copies of the dissertation, along with the approval pages and special abstract, to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier. The College of Education requires two additional copies of the dissertation, one for the College of Education files and one for the dissertation director. A manual of instructions relating to the form of the dissertation may be obtained from the Associated Students’ Bookstore.

Publication of Dissertation
Dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee is charged to cover this expense. Upon certification by the student’s major professor, members of the committee for the final examination, and the Graduate College, a copy and an abstract of no more than 350 words are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for inclusion in the dissertation and must be carefully prepared for microfilming according to specifications set forth in the Dissertation Manual.) The manuscript is microfilmed and the negative inspected and put in vault storage. The manuscript is cataloged and the catalog information sent to the Library of Congress for printing and distribution of cards to depository catalogs and libraries. The abstract is included in the forthcoming issue of Microfilm Abstracts, which is distributed to leading libraries here and abroad, and to a selected list of journals and abstracting services. The first copy is then returned to the University of Arizona Library.

Publication by microfilm does not preclude publication by other methods, and successful candidates are urged to submit dissertation material for publication in a scholarly or professional journal. Suitable acknowledgement must always indicate the publication to be a dissertation or portion of a dissertation, submitted in partial fulfillment of the requirements for the degree of Doctor of Education at the University of Arizona.

DOCTOR OF MUSICAL ARTS
The School of Music, through the Graduate College, accepts prospective candidates for the degree of Doctor of Musical Arts. The degree is granted in the fields of composition, conducting, and performance. It is not granted merely as a certificate of faithful performance of a prescribed program of studies but requires demonstration of distinguished attainment. Information about the Doctor of Philosophy degree with a major in music theory or music education will be found under “Music” in this catalog.

Preliminary admission to the program is recommended by appropriate School of Music faculty members and the Director of Graduate Studies in Music. Before a recommendation can be made, the applicant must file an application for admission to the Graduate College and must forward transcripts of all previous college work to the Dean of the Graduate College. Performers and conductors must submit a tape recording and/or have a personal audition with the area faculty concerned. Applicants for a major in composition must submit scores and tapes of their own works in performance.

Residence and Credit Requirements
The equivalent of at least six semesters of essentially full-time graduate study is required. Graduate credit earned at other approved institutions, if accepted by the School of Music and
the Graduate Council, may be counted toward the requirements for this degree.

To meet the minimum residence requirement, the student must spend three semesters or the equivalent of essentially full-time academic work in the Doctor of Musical Arts program in actual residence at The University of Arizona, and at least 30 units of graduate credit must be completed at this institution. Any semester during which a student is registered for at least nine units of graduate course work or research will be counted toward meeting the residence requirement, provided that the student's full time is devoted to graduate work. (See next paragraph for the only exceptions to this general requirement.)

A student who proceeds directly, without a break in enrollment, from a master's degree to a doctoral degree in the same major, may be permitted to apply one or more semesters of full-time enrollment in the master's program toward the residence requirement for the doctoral degree. If there is a change of major or a break in enrollment, the residence requirement must be fulfilled again for the doctoral degree. Graduate assistants or graduate associates and students on appointment to any teaching or research position at the University can discharge the minimum residence requirement by four semesters during each of which they register for six or more units of work for graduate credit, provided their full time is devoted to their graduate work and meeting the responsibilities of their appointments.

At the beginning of the first semester in residence, diagnostic examinations in Music History and Music Theory must be taken if not already completed.

All requirements for the Doctor of Musical Arts degree, including work done for the master's degree (if applicable), cannot exceed a period of ten years.

**Major and Minor Subjects**

The student will major in conducting, composition, or performance, and choose a minor subject in another area of music or in a department other than music if approved in the candidate's program of study.

**Qualifying Examination**

For the purpose of demonstrating acceptability to undertake work leading to candidacy for the Doctor of Musical Arts degree, each applicant must pass a qualifying examination in the proposed major field and minor fields and in other related areas. The minor examination may be waived at the option of the department concerned. In order to make the most effective use of the results of the examination in establishing the student's course of study, the examinations should be taken during the first semester in residence. In addition, a personal interview, a review of the applicant's college record and musical achievement, and evidence of an ability to write in a clear and precise manner are required.

**Advisory Committee**

The Director of Graduate Studies in Music, upon the recommendation of the School of Music Graduate Committee, will appoint an advisory committee representing the major and minor fields of study for each candidate. The chairperson will be the student's major professor.

**Program of Study**

A proposed program of study recommended by the School of Music and any other department concerned must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the units be offered in 500-level or above, University credit courses, and that at least one half of the required units be offered in university graduate credit courses in which regular grades (A, B, C) have been earned. (For specific degree requirements, consult the paragraphs on the specific requirements for the majors in composition, conducting and performance at the end of this section.)

**Preliminary Examination**

Before admission to candidacy for the degree, the student must pass a general examination in the chosen fields of study. This examination is intended to test the student's general fundamental knowledge of the fields of the major and minor subjects of study. It shall include written portions covering the major and minor fields and an oral portion which shall be conducted before a committee of the faculty appointed by the Dean of the Graduate College upon consultation with the major and minor departments. The written and oral portions of the preliminary examination shall take place within two successive semesters, not including summer sessions. No later than three weeks prior to the proposed date of the examination, the Request to Schedule Preliminary Oral examination must be filed with the Graduate College. The preliminary examination will be held when essentially all course work has been completed and in any case not later than three months prior to the date of the final oral examination. No student will be permitted a second attempt to pass the preliminary examination except upon recommendation of the examining committee, endorsed by the major faculty and approved by the Graduate Council. The second examination, if approved, may not take place until four months from the date of the first examination. The only visitors permitted at the preliminary examination are regular University faculty members.

**Final Examination**

When the required standards of scholarship have been met, the candidate shall submit to an oral examination including any general questioning related to the field of study. The exact time and place of this examination shall be scheduled with the Graduate College at least three weeks in advance and announced publicly at least one week in advance. The examination shall be open to the public. The committee shall be appointed by the Dean of the Graduate College in consultation with the School of Music.

**Specific Requirements for the Major in Composition**

Approval of a major in composition will be based upon evidence of creative talent and a knowledge of craftsmanship in writing music. In lieu of a dissertation, the candidate will compose a major work of approximately thirty minutes duration. Registration for a minimum of eighteen units of dissertation credit (920) is
required during the preparation of the composition. Following the final examination, the Graduate College Representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Certification Office. The candidate submits two complete and signed copies of the composition (approved and accepted by the School of Music and all members of the examining committee), together with approval pages and special abstract, for delivery to the University Library. The School of Music, at its option, may require an additional copy for its files. Regulations governing publication of the composition are the same as those governing publication of a Ph.D. dissertation. A processing fee must be paid to the University Cashier.

In addition to the composition of an extended work, a recital consisting of the candidate's compositions in several forms and a variety of media must be presented.

Specific Requirements for the Major in Conducting

Requirements are the same as for Performance majors (see below), except that conductors generally fulfill each recital requirement (except the lecture recital) through several performances with major university ensembles. Conductors work in a secondary conducting area for the second recital. Following the final examination, the Graduate College Representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Certification Office. The candidate submits two complete and signed unbound copies of the lecture document (approved and accepted by the School of Music and all members of the examination committee) to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier.

Specific Requirements for the Major in Performance

In lieu of a dissertation, the candidate must present the following four recitals: (1) a qualifying recital during the first semester in residence (2) a program of vocal and/or instrumental chamber music, (3) a solo recital, and (4) a lecture-recital (must follow a successful preliminary examination). No more than one recital is permitted per semester. Registration for eighteen units of doctoral recital credit (925) is required during the preparation of the recitals, with a maximum of nine units during any regular semester.

The four recitals must include representative literature from all major periods. Each recital will be evaluated independently by the student's advisory committee and area faculty. Should the candidate's performance be judged unsatisfactory, an additional recital composed of different literature must be performed. In no case will a candidate be permitted to remain in the program should more than one recital be determined unsatisfactory.

The candidate will prepare and submit a formal document in connection with the lecture-recital. This document, based on some aspect of performance or performance practice, must show evidence of the candidate's ability to select and organize data pertinent to the study. The document should be an original contribution to the field of knowledge in the candidate's chosen subject area, and should demonstrate the candidate's ability to communicate effectively in writing. Following a successful final oral examination, the candidate will submit one bound copy of the Lecture Recital Document to the University Music Library for placement in its permanent collection. The candidate will submit two complete and signed unbound copies of the document (approved and accepted by the School of Music and all members of the examining committee) to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier.
DEPARTMENTS AND COURSES OF INSTRUCTION

COURSE LISTING INFORMATION

CURRICULAR CHANGE—Course listings in the following departmental sections are subject to change. Curriculum changes approved during the first year of the catalog's biennial are listed in the Supplement to the University of Arizona Catalog, published approximately one year after publication of the biennial catalog. A copy of this publication is available upon request from the University Curriculum Office.

CLASS SCHEDULES—To confirm or identify the semester of offering for any course, students should consult the Schedule of Classes for each term. Schedules for fall and spring classes are available in April and October, respectively. The Summer Session Schedule of Classes is available in February.

PREREQUISITES—Students must meet the course prerequisites or otherwise satisfy the instructor of their preparation to take the course. Prerequisites can be waived only at the discretion of the instructor or department involved.

CANCELLATION OF COURSES—The University reserves the right to cancel courses not elected by an adequate number of students.

COURSE NUMBERING CLASSIFICATION SYSTEM

The number by which a course is designated indicates the level of the course. Courses are numbered as follows:

500-599: Graduate courses. Open to exceptionally well-qualified seniors with the prior written approval of the course instructor and the Graduate College.

600-699: Graduate courses. Not open to undergraduates.

700-799: Graduate courses limited to doctoral students.

800-899: Courses limited to students working toward degrees offered by the College of Medicine or the College of Pharmacy. Not available for credit toward other degrees.


Certain 400- and 500-level courses with the same number and title may be convened jointly. Students may receive credit for such courses only once, whether jointly convened or separately, unless designated [Rpt.] or unless special approval is granted by the student's major advisor.

Semester Courses (Single Numbers)

A course designated by a single number (as ECON 560) is one semester in length.

Year Courses (Double Numbers)

A course designated by a double number (as POL 610a-610b) is continued through two successive semesters, the work of the first semester being prerequisite to that of the second unless otherwise indicated in the statement of prerequisites.

HOW TO READ COURSE DESCRIPTIONS

Following is a standard course description with the individual symbols explained in the order in which they appear in the description.

Sample Course Listing:

506. Social Structure in Modern Societies (3) [Rpt.] I 1993-94
GRD Critical review of modern theory and research on social structure and social organization in modern societies. 2R, 3L. P, 6 units of sociology or CR. (Identical with HIST 506) Smith

Explanation:

506.—Course number.

Social Structure in Modern Societies—Course title.

(3)—Number of units.

[Rpt.]-May be repeated for credit. A restriction regarding the number of times a course may be repeated for credit (beyond the student's first enrollment) or the total number of units of credit permitted for a course may be designated. [Rpt.] indicates that the course may be repeated for credit once, for a total of two enrollments. [Rpt./2] indicates that the course may be repeated for credit twice, for a maximum of three enrollments in the course; [Rpt./6 units] means that the course may be repeated until the student has received a total of 6 units of credit. It is the student's responsibility to ensure that course content is not duplicated.

I—Semester in which course is usually offered. I indicates fall semester; II, spring; S, summer. To ascertain course offerings for a particular semester, consult the Schedule of Classes.

1993-94—Year in which course is offered. If no year designation is given, the course is offered each year.

Critical review . . . societies—Course description.

2R, 3L—Class structure. R, L, S, and D indicate "recitation," "laboratory," "studio" and "discussion". 2R, 3L indicates that the class meets for two hours of recitation and three hours of laboratory per week (based upon 15 weeks). For courses consisting of recitation (lecture) periods only, the number of class hours per week is the same as the unit value and is not specified in the course listing.

In addition to the above abbreviations for class structure, the College of Engineering and Mines uses the abbreviations ED and ES to designate the number of units in the areas of "engineering design" and "engineering science". Thus 1ED, 2ES signifies that the course meets the requirement for 1 unit of engineering design and 2 units of engineering science.

P—Prerequisites. Identifies courses or other experiences which must be completed prior to enrolling in the course listed.

CR—Concurrent registration. Identifies courses which must be taken during the same term as the course listed.

(Identical with HIST 506)—Crosslisting. Identifies other departments which give credit for the same course. The complete course listing is shown in the course list of the "home" department which has instructional responsibility for the course. An abbreviated listing appears in the course list of the "crosslisting" department. Exceptions are house-numbered courses, which do not have course descriptions.

Smith—Professor in charge.

Note: Not all of the above information may be noted in any individual course.

UNIVERSITY-WIDE "HOUSE-NUMBERED" COURSES

Most University of Arizona courses use a combination of lectures, discussions and laboratories as their basic teaching format. University-wide "house-numbered" courses identify alternative teaching formats which emphasize student participation, typically in small group or individual settings.
Small-group courses are identified by numbers ending in 95, 96 or 97. The area of study for such courses is indicated through a subscript and subtitle. Individual-studies courses are those with numbers ending in 91, 93, 94, 98* and 99, as well as all 900-level courses. Under their generic numbers and titles, and without subscripts, they are available for use by all departments at the course-number levels appropriate to the departments' academic programs.

**Small Group Courses**

595, 695, 795. Colloquium (Credit varies) The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

*Grades Available: A, B, C, D, E, I, S/P*, W.

596, 696, 796. Seminar (Credit varies) The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.

*Grades Available: A, B, C, D, E, I, S/P*, W.

597, 697, 797. Workshop (Credit varies) The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.

*Grades Available: A, B, C, D, E, I, W.

*Special (i.e., S, P, C, D, E) or regular grades may be used as departmental policy dictates; however, in any single course offering, all registrants must be graded by the same system.

**Individual Studies**

591, 691, 791. Preceptorship (Credit varies) Specialized work on an individual basis, consisting of instruction and practice in actual service in a department, program, or discipline. Teaching formats may include seminars, in-depth studies, laboratory work and patient study.

*Grades Available: S/P, C, D, E, I, W.

593, 693, 793. Internship (Credit varies) Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.

*Grades Available: S/P, C, D, E, I, W.

593L Legislative Internship (9) II Working experience at the Arizona State Legislature; responsibilities draw upon student's area of major expertise and include preparing written and oral reports, summarizing legislative proposals, and providing information to legislators and legislative committees. Participating programs include but are not limited to: architecture, economics, English, geography and regional development, history, hydrology, journalism, management, management information systems, marketing, political science, psychology, public administration, secondary education, sociology, statistics, and urban planning. Students in other programs are eligible and should consult the department head or, in the case of the College of Law, the dean, for appropriate arrangements.

*Grades Available: A, B, C, D, E, I, W.

594, 694, 794. Practicum (Credit varies) The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.

*Grades Available: S/P, C, D, E, I, W.

599, 699, 799.* Independent Study (Credit varies) Qualified students working on an individual basis with professors who have agreed to supervise such work.

*Grades Available: S/P, C, D, E, I, W.

900. Research (Credit varies) Individual research, not related to thesis or dissertation preparation, by graduate students.

*Grades Available: S/P, C, D, E, I, W.

908. Case Studies (Credit varies) Individual study of a particular case, or report thereof.

*Grades Available: S/P, E, K, W.

909. Master's Report (Credit varies) Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.

*Grades Available: S/P, E, K, W.

910. Thesis (Credit varies) Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.

*Grades Available: S/P, E, K, W.

915. Master's Recitals (Credit varies) For master's students in performance.

*Grades Available: S/P, E, K, W.

920. Dissertation (1 to 9) Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).

*Grades Available: S/P, E, K, W.

925. Doctoral Recitals (1 to 9) For doctoral students in music performance.

*Grades Available: S/P, E, K, W.

930. Supplementary Registration (1 to 9) For students who have completed all course requirements for their advanced degree programs. May be used concurrently with other enrollments to bring to total number of units to the required minimum.

*Grade Available: K.

*Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Faculty Lists
The listing of faculty which precedes the departmental course offerings identifies tenured and tenure-track faculty members appointed for the 1992-93 academic year, as well as emeritus faculty. A department designation in parentheses following a faculty member's name identifies the department in which the primary appointment is held. These designations appear only in cases of multiple appointments. For identification of Regents' Professors as well as the complete listing of tenured and tenure-track faculty, consult the last section of this catalog.

Courses
Permanent graduate-level courses offered by The University of Arizona are listed on the following pages by department or committee in alphabetical order. For a complete listing of courses offered, see the University of Arizona General Catalog.

Accounting (ACCT)
McClelland Hall, Room 301
(602) 621-2620

Professors Andrew D. Bailey, Jr., Head, William B. Barrett, Dan S. Dhaliwal, William L. Felix, Jr., William S. Waller
Assistant Professors Sanjay Kallapur, Sharon S. Lassar, Jeffrey W. Schatzberg, Galen R. Sevick, Brian P. Shapiro, Mark A. Trombley, Cynthia C. Vines, Shing-wu Wang

The department offers a program leading to the Master of Accounting degree with a major in accounting. The department also participates in programs leading to the Master of Business Administration (major in business administration), Master of Public Administration (major in public administration), and Doctor of Philosophy (major in management) degrees. For information concerning these degrees, see Requirements for Master's Degrees/Master of Business Administration, Master of Public Administration and see also Business Administration and Management and Policy headnotes elsewhere in this catalog.

500a-500b. Intermediate Financial Accounting (3-3) I II Theory and methodology involved in contemporary accounting for assets, liabilities, stockholders' equity, net income and funds; analysis and interpretation of financial statements. Credit allowed for this course or 400a, but not for both. P, 550. Open to MBA candidates only.

501. Advanced Accounting (3) I II Theory and methodology involved in the preparation of consolidated financial statements and in accounting for partnerships. Credit allowed for this course or 401, but not for both. P, 400b or 500b. Open to MBA candidates only.

510. Principles of Profit Planning and Control (3) I II Examination of the value of managerial accounting in organizational decision-making and control, addressing specific managerial accounting problems and their solution. P, 410 or 450. Credit for this or 410 but not for both.

520. Advanced Federal Taxation (3) I II Introduction to advanced topics: taxation of corporations and stockholders' transactions in stocks; taxation of partnerships and fiduciaries; gift and estate taxation. Credit allowed for this course or 422, but not for both. P, 420/520.

525. Issues in Accounting and Taxation (3) I Professional discussion of current issues such as estate and income tax, financial planning, IRS audits, bankruptcy, accounting developments and accounting in business formation. Credit allowed for this course or 425 but not both. P, 420/520.


529. International Corporate Taxation (3) I Concepts of U.S. taxation of international transactions, including rules for sourcing income and allocating deductions and such fundamental multistate concepts as nexus, unitary taxes and apportionment. Credit allowed for this course or 429, but not for both. P, 422/522 or permission of instructor.

531. Principles of Auditing (3) I II The opinion formulation process of the professional auditor; the auditor's reports, professional standards, internal and operational auditing. Credit allowed for this course or 431, but not for both. P, 400b/500b. Open to MBA candidates only.

535. Responsibilities of the Public Accountant (3) I II A professional course for those who expect to pursue public accounting as a career. P, 431.

550. Financial Accounting (3) I II Principles and procedures underlying basic financial accounting processes and their application in the preparation and analysis of financial statements. Advanced degree credit available for nonmajors only. Open to MBA candidates only.

551. Analysis of Financial Statements (3) I I An examination of the demand and supply forces underlying the provision of financial accounting, the properties of financial statement information. Credit for this course or 451 but not for both. P, 400b/500b.


707. Management and Evaluation of Information Systems (3) I II (Identical with MIS 570)

*May be convened with 400-level course.


797. Seminar (1-3) I II (Rpt) Credit only to graduate students in accounting.

Aerospace and Mechanical Engineering (A ME)
AME Building, Room 301
(602) 621-2235


Associate Professors Ara Arabyan, Abhijit Chandra, Kee-Ying Fung, Edward J. Kerschen
Assistant Professors Cholik Chan, Yong-gang Huang, Jeffrey W. Jacobs, Er-dogan Madenci, Alfonso Ortega, Karl Ousterhout, K.R. Sridhar

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in aerospace engineering or in mechanical engineering. Students in either major may select one of the following interdisciplinary options: biomedical engineering, energy systems engineering, materials engineering, or reliability engineering. For information concerning these options see Engineering elsewhere in this catalog. A Bachelor of Science degree from an aerospace or a mechanical engineering curriculum of a recognized institution of higher education is required of applicants to the graduate program. In general, a grade average of "B" or better in previous academic work is expected. Graduates from other engineering, mathematics, and physical sciences curricula may be admitted provisionally. All applicants must submit scores from the Graduate Record Examination general test.

Master of Science: All students are required to complete 32 units of graduate work, including 2 units of 696. All students are required to complete 500a and 500b. (Students in the reliabilty engineering option may take 574 and STAT 566a -566b or SIE 550 as a substitute.) Students may elect to present a Master's thesis (six units of 910), a Master's report (three units of 909), or complete a course work option. No more than three units of independent study are allowed for the course work option. No independent study units are allowed for the thesis or report options. All students are expected to attend the weekly graduate seminar. A final examination is required. Specific departmental M.S. degree requirements and examination procedures are described in the departmental Graduate Program booklet.

Doctor of Philosophy: All students are required to complete a minimum of 54 units of graduate course work (including 30 units, other than 696, earned for the M.S. degree), 18 units of 920 dissertation, and 3 units of 696. Each student must pass the Qualifying Examination. After completing all or nearly all the required course work, the Preliminary Examination may be scheduled. The Preliminary Examination in the major field is taken after the student has passed the examination on the minor field. Minor fields may be chosen from other engineering, physical sciences, or mathematics departments. A final oral examination including dissertation defense is required. Doctoral students are expected to attend the weekly graduate seminar. In order to obtain the last unit of 696, all degree candidates are required to present a departmental seminar on their research during the last year in residence. Specific departmental Ph.D. degree requirements and examination procedures are described in the departmental Graduate Program booklet.


502. Modeling and System Identification in Dynamic Engineering Systems (3) 1993-94 Principles of mathematical modeling of engineering problems; state and parameter identification techniques; lumped and distributed system; open loop (explicit) and closed loop (implicit) applications; frequency and time domain representation; deterministic and stochastic inputs. P, 502; CR, 455.

510. Design for Manufacturing (3) I Design methodology—axiomatic, algorithmic, hybrid. Concepts of design sensitivity; applications to several manufacturing processes—metal forming, metal cutting, welding. P, 461 (AI programming ability; knowledge of plasticity).


520. Aircraft Conceptual Design (3) I II Student groups develop conceptual designs for aircraft with specified performance and figures of merit. Design issues include program organization, configuration, aerodynamics, weights, and performance. Design groups develop computer flight simulators to evaluate performance. P, 320, 321, 323.


524. Introduction to Space Technologies (3) I The space environment: vacuum, microgravity, radiation(s), free molecule flow and drag on bodies. Resource utilization in deep space. Space transportation, spacecraft thermal design, automation and robotics, communications, space power, space structures. P, 323, 324; CR, 425, 455.


528. Space Mission Conceptual Design (3) II Introduction to space mission design and modern tools available to aid the designer. Includes brief case histories of some of the more successful space missions and design of a mission. 3ED, P, 424.

530. Advanced Thermodynamics (3) II Reversible and irreversible macroscopic thermodynamics; selected engineering applications. P, 230, 331a.


532. Convective Transport Phenomena (3) Convective energy, mass and momentum transfer; internal and external flow; exact, approximate and numerical solutions; applications to current problems. P, 432; CR, 500a, computer programming ability.

534. Radiative Heat Transfer (3) 1993-94 Fundamentals of radiative heat transfer; radiative properties of materials; gray-body and spectral exchange between surfaces; radiating media; radiation combined with conduction and convection. Intended for students with strong interests in heat transfer, combustion, and applications such as energy conversion systems, materials processing, and space technology. P, 432.


537. Fluid Mechanics of Viscous Flows (3) Behavior of viscous fluids over a range of Reynolds numbers; Navier-Stokes equations; boundary layer equations; slow flow; compressible boundary layers. P, 536b.

538. Nature of Turbulent Shear Flow (3) 1994-95 Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances. P, 500b; 536a-536b.


542. HVAC System Design (3) I (Identical with NEE 542).

545. Solar Energy Engineering (3) I (Identical with NEE 545).
Aerospace and Mechanical Engineering—Agricultural and Biosystems Engineering

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547.* Direct Energy Conversion (3) II (Identical with NEE 547)


552. Computer-Aided Analysis of Mechanical Systems (3) I Kinematic and dynamic analysis of mechanical systems in planar motion, numerical methods and use of computer programs in analysis. 2ES, 1ED, P. 302.


556.* Control of Manufacturing Process (Process) I Modeling and control of manufacturing processes. Mathematical modeling of processes, actuators, transducers and sensors; classical control methods including transient response steady-state errors, bode diagrams; root locus and design of closed loop control systems; introduction to digital control systems and robotics; hardware and software issues; computer simulations. 1R, 2L. P, 250, 300, 331b, CR, 411.


561. Finite Element Analysis in Structural Mechanics (3) II Advanced problems in structural analysis using the finite element method; analysis of complex systems; dynamics, Composite structures and material systems; program development. P, 461.

562.* Composite Materials (3) II Classification and characteristics of composite materials; mechanical behavior of composite materials; micro- and macro-mechanical behavior of laminae; mechanical behavior of laminates; mechanical behavior of short fiber composites. P, 302, C 217.

563. Finite Element Analysis in Nonlinear Solid Mechanics (3) I 1994-95 Finite element methods, including material nonlinearities (elastic, plastic, viscoelastic); geometric nonlinearity (finite deformations), numerical solution methods, and nonlinear programs. P, 461.

566.* Biomechanical Engineering (3) II 1994-95 One subject covered yearly from: biomedical-solids mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation exercise, hyperthermia, instrumentation). P, 302, 330, 331b, 410.

572.* Reliability Engineering (3) I Time-to-failure, failure rate, and reliability determination for early, useful, and wear-out lives; equipment reliability prediction; spare parts provisioning; reliability allocation. P, CR, 474 or SIE 330.

573.* Probabilistic Mechanical Design (3) I Application of probability theory and statistics to mechanical and structural design; modern mechanical reliability methods; design philosophy. P, C E 217; CR, 410.


575. Reliability Testing (3) II Mean-time-between-failure and reliability confidence limits; sequential testing; sampling; accelerated, sudden-death, and suspended-item non-parametric, and Bayesian testing. P, 472.

576. Advanced Probabilistic Design (3) II Advanced methods for mechanical and structural reliability analysis, system reliability analysis, random loading models, applications to fatigue, fracture, buckling, creep, etc. P, 473.

579. Biomechanical Engineering (3) II 1994-95 Subject covered yearly from: biomechanical-solids mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation exercise, hyperthermia, instrumentation). P, 302, 330, 331b, 410.

579. Biomechanical Engineering (3) II 1994-95 One subject covered yearly from: biomechanical-solids mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation exercise, hyperthermia, instrumentation). P, 302, 330, 331b, 410.


595. Colloquium a. Research Conference (1) I II 696. Seminar g. Graduate Seminar (1) I II

Agricultural and Biosystems Engineering (ABE)

Shantz Building, Room 507
(602) 621-1607

Professors Donald C. Slack, Head; Delmar D. Fangmeier, Martin M. Fogel (Emeritus); Kenneth R. Frost (Emeritus); Stuart A. Hoenic (Emeritus), Kenneth A. Jordan, W. Gerald Matlock (Emeritus), Gene M. Nordby, W. David Shoup, Frank Wiersma (Emeritus), Associate Professors Wayne E. Coates, Dennis L. Larson, William O. Rasmussen, Muluneh Yitayew, Assistant Specialist Edward Martin

The department offers graduate work leading to the Master of Science and Doctor of Philosophy degrees in agricultural and biosystems engineering.

Opportunities for study and research in several areas of concentration exist, including the following: irrigation and water resources management and development; biosystems and biochemical engineering with emphasis on biotechnology developments; energy issues and alternatives; biosystems analysis and design; waste management and water quality control; soil, water, plant relationships; environmental control and materials handling in agri-biosystems production; and, applications of sensors, control systems; computer applications including digital imaging, computer vision, artificial intelligence and multispectral analysis; robotics; and emerging technologies in these areas.

Students with adequate undergraduate preparation in engineering will be considered for admission to a degree program.

A thesis is normally required, but the requirement may be waived for a student who is the senior author of a manuscript published or accepted for publication in a refereed professional journal.
454. Irrigation Principles and Management (3) I 1993-94 Principles of operating farm irrigation systems, evaluation of systems, selection of systems, basic irrigation scheduling, measurements of water flow, soil moisture, and system efficiencies. 2R, 3L. Field trip. P, MATH 117R/S, S W 200. (Identical with S W 504)

506. Applied Hydraulics (3) I Fundamentals of hydraulics applicable to the irrigation of agricultural lands, including fluid properties, hydrostatics, irrigation flow characteristics, open channel and pipeline applications, and measurements of flowing water. Not for ABE majors. P, MATH 118, 123 or 125a, PHYS 102a. Yitayew

508. Environmental Simulation (3) I Introduction to the design, development, and usage of simulation tools and techniques to assist in analyzing physical, chemical and biological components of the environment. P, MATH 123 or 124a. Rasmussen


523. Agricultural Systems Analysis and Design (3) II 1994-95 Application of systems analysis to agricultural and biologically related problems; computer modeling and use of operations research methods. P, STAT 361. Larson

527. Sensors and Controls (3) I The selection, interfacing, and calibration of digital and analog sensors to measure physical variables for manipulation with microprocessors. The development of logic and process control circuits. 2R, 3L, P, ECE 207.

550. Small Scale Water Management Systems (3) I Design, construction, testing and operation of water management systems for small scale operators; water harvesting; runoff farming. Field trips. P, 6 units of hydrology, hydraulic or irrigation.

555. Irrigation Engineering (4) II Introduction to soil and water relationships, irrigation systems, irrigation water supply, and irrigation management; basic designs. P, C E 321 or A ME 331a. (Identical with C E 555)


557. Irrigation Engineering Laboratory (1) I Data acquisition and analysis pertinent to the design and evaluation of irrigation systems. 3L, 1ES. Field trip. CR 455.

558. Drainage of Irrigated Lands (3) 1993-94 II Origin and nature of drainage problems in arid lands; drainage theories, investigations and design for irrigated agriculture. Field trip. P, C E 521 or A ME 331a. (Identical with C E 558)


563. Energy from Biomass (3) II Biomass energy sources; collection and processing methods; thermal, anaerobic digestion and fermentation conversion processes, energetic, economic and environmental issues. P, A ME 230. (Identical with NEE 565) Larson


566. Pressurized Irrigation Systems (3) II 1994-95 Analysis of design and operating criteria for sprinkler and trickle or drip irrigation systems, hydraulics of sprinklers and emitters, hydraulics of pipe systems. P, 456.

605. Soil-Water Dynamics (3) II 1994-95 (Identical with S W 605)

606. Advanced Irrigation Management (3) II 1993-94 Irrigation scheduling using Jensen-Haise and Penman equations for predicting evapotranspiration, determination of crop coefficients; production functions, economics, and energy considerations. P, 404 or 455 or S W 520.

653. Seminar (2) I II Yitayew

a. Agricultural and Biosystems Engineering (1) [Rpt/1] I II Yitayew

Agricultural and Resource Economics (AREC)

Economics Building, Room 208
(602) 621-6241

Professors Bruce R. Beattie, Head, Robert C. Angus, Bartley P. Cardon (Emeritus), Dennis C. Cory, Robert S. Finch (Emeritus), Roger W. Fox, Jimmye S. Hillman (Emeritus), Maurice M. Kelso (Emeritus), Robert O. Kuehl, Jeffrey T. LaFrance, William B. Lord, William E. Martin (Emeritus), Eric A. Monke, Lester D. Taylor

Associate Professors Bonnie C. Colby, Roger A. Dahlgren, Robert D. Innes, Paul N. Wilson

Assistant Professors Satheesh V. Aradhuya, Gary D. Thompson

Research Scientist Edwin H. Carpenter

Extension Specialists Harry W. Ayer, Russell L. Gum, James C. Wade

Assistant Extension Specialists Julie Leones, Russell E. Tronstad

The department offers a program leading to the Master of Science degree with a major in agricultural and resource economics. A broad spectrum of agricultural economics subject matter is presented by the department, with special emphasis given to the economics of natural resources. In cooperation with the Department of Economics, work is also offered leading to the Doctor of Philosophy in economics with emphases in international agricultural economic development and natural resource economics.

Students in the Master of Science degree program have a choice between thesis and nonthesis programs. Students completing a thesis are required to complete a minimum of 30 semester units which may include up to six units of credit for thesis research. Students completing the nonthesis option must complete 33 semester units.

500. Research Methodology in Agricultural Economics (3) I Study of the research process in agricultural economics as a means for acquiring reliable knowledge. P, ECON 518, ECON 504 or CR. Cory

504. Production Economics (3) I Theory of the firm and industry; single and multiple products; risk and uncertainty. (Identical with ECON 504) P, MATH 123, ECON 300 or 361. Aradhya

512. Economic Policy in Developing Countries (3) II The role of policies in economic growth and development. The impact of commodity factor market and macroeconomic policies on economic incentives. (Identical with AR L 512 and ECON 512) Monke

513. Consumption Economics and Price Analysis (3) II Theory of the consumer, demand, market equilibrium and welfare analysis. P, ECON 361, MATH 123. (Identical with ECON 513) LaFrance

514. Cost-Benefit Analysis (3) I Theoretical bases and empirical techniques, with emphasis on LDCs. Consumer-producer surplus; social and private costs; macroeconomic distortions; non-market goods; uses in policy analysis. (Identical with ECON 514) Monke

515. Operations Research in Applied Economics (3) I Application of linear, nonlinear, and multiple objective programming, decision theory, and simulation to problems of agricultural production, marketing, policy, and natural resource use. P, ECON 361, MATH 123. (Identical with ECON 515) Thompson

516. Agricultural Development (3) [Rpt/1] I Microeconomic analysis of agriculture in developing economies, focusing on factors affecting production decisions of small farmers, including adoption of new technologies. Interrelationships between agricultural activities and household consumption patterns
Agricultural Education (AED)

Forbes Building, Room 224
(602) 621-1523

Professors Roger T. Huber, Head, Clinton O. Jacobs (Emeritus), Floyd G. McCormick (Emeritus), Kenneth S. Olson, Phillip R. Zurbrick

Associate Professor David E. Cox, Glen M. Miller
Assistant Professor Jack Elliott

The department offers programs leading to the Master of Science and the Master of Agricultural Education degrees with a major in agricultural education.

Degrees

Master of Science: The program requires the completion of at least twenty units in agriculture and agricultural education. Supporting course work shall be in plant sciences, animal sciences, entomology, soil and water sciences, environmental sciences, agricultural and resource economics, renewable natural resources, agricultural and biosystems engineering, educational administration, higher education, teaching and teacher education or in other disciplines appropriate to teaching; extension, or similar educational work. Thirty units, including a thesis (for which a maximum of six units may be earned) must be completed.

Master of Agricultural Education: For information concerning this degree see Requirements for Masters' Degrees/Master of Agricultural Education elsewhere in this catalog.

Agriculture (AGRI)

Forbes Building, Room 201
(602) 621-3612

Within the College of Agriculture, programs are offered leading to the Master of Science (M.S.), Master of Agricultural Education (M.Ag.Ed.), Master of Home Economics Education (M.H.E.E.), Master of Landscape Architecture (M.L. Arch.), and Doctor of Philosophy (Ph.D.) degrees as indicated in the following list of departments and majors:

Agricultural and Resource Economics

agricultural and resource economics ............... M.S.

Agricultural Education

agricultural education ......................... M.S./M.Ag.Ed.

Agricultural and Biosystems

Engineering

agricultural and biosystems engineering ........ M.S./Ph.D.

Animal Sciences

animal science ......................... M.S./Ph.D.
dairy science ......................... M.S.
poultry science ......................... M.S.

Entomology

entomology ......................... M.S./Ph.D.

Family and Consumer Resources

counseling and guidance ................. M.A.

family and consumer resources ........... M.S./M.Ed./Ph.D.

Home Economics

education ......................... M.S./M.H.E.E.

Nutrition and Food Science

dietetics ......................... M.S.

food science ......................... M.S.

Nutritional Sciences

nutritional sciences ................. M.S./Ph.D.

Plant Pathology

plant pathology .................... M.S./Ph.D.

Plant Sciences

Plant Science ......................... M.S./Ph.D.

Renewable Natural Resources

landscape architecture ............... M.L. Arch.

range management .................... M.S./Ph.D.
The American Indian Studies (AINS) Graduate Interdisciplinary Program in American Indian Studies

Committee:

Professors Joseph (Jay) H. Stauss (Family and Consumer Resources), Director, Barbara A. Babcock (English), James W. Clarke (Political Science), Lawrence J. Evers (English), Jerrold E. Levy (Anthropology), N. Scott Momaday (English), J. Jefferson Reid (Anthropology), Robert Williams, Jr. (Law)

Associate Professors Thomas M. Holm (Political Science), Jennie R. Joe (Family and Community Medicine), Alice S. Paul (Teaching and Teacher Education), Ofelia Zepeda (Linguistics)

Assistant Professors William deReuse (Anthropology), Teresa L. McCarty (Language, Reading and Culture), Michelle Taigue (English), David E. Wilkins (Political Science)

The American Indian Studies interdisciplinary graduate program offers opportunities for advanced study in the following concentrations: American Indian law and policy; American Indian societies and culture; American Indian languages and literatures.

Graduates of the program have assumed leadership roles with tribes, federal or other governmental agencies, pursued a Ph.D. or J.D., or followed their own literary or scholarly pursuits.

The American Indian Studies Program also offers a non-thesis option. Contact the Director or Graduate Coordinator for option requirements.

Applicants for admission normally submit letters of recommendation, two writing samples and the personal and academic data called for on the American Indian Studies application form.

Applicants are also invited to submit vita, published articles or other materials relevant to admission.

502a-502b. Dynamics of Indian Societies (3-3) Philosophies, institutions and characteristics of tribal life in North America. 502a: American Indian life-styles prior to European contact. 502b: Impact of European immigration on tribal groups of North America. (Identical with ANTH 502a-502b)

513. * Ethnology of the Southwest (3) II (Identical with ANTH 513)

516. * Contemporary Indian America (3) II (Identical with ANTH 516)

523. * Anthropology of Mexico (3) II (Identical with ANTH 523)

524. * Studies in Southwest Literature (3) I II (Identical with ENGL 524)

530. * The Anthropology of Visual Art (3) II (Identical with ANTH 530)

545a-545b. * Structure of a Non-Western Language (3-3) [Rpt./2] (Identical with LING 545a-545b)

549a-549b. * Folklore (3-3) (Identical with ENGL 549a-549b)

577. * American Indian Literature (3) I I (Identical with ENGL 577)

582. * Hopi Language in Culture (3) I I (Identical with ANTH 582)

584a-584b. * Development of Federal Indian Policy (3-3) (Identical with POL 584a-584b)

587. * Race and Public Policy (3 I (Identical with POL 587)

590. * Indian Religions and Spirituality (3) Examines the positive (curing, harmony with the natural world, etc.) aspects of Indian religions. Indian medicine men may participate in the course at various junctions.

595. Colloquium
   a. American Indian Studies (3) II [Rpt/4]

596. Seminar
   a. American Indian Studies (1-2) [Rpt/3 I II
   h. American Indian Law and Policy (3) [Rpt./2] II I II (Identical with POL 596h, which is home.)
   m. Studies in the Oral Tradition (3) [Rpt./9 units] I II (Identical with ENGL 596m, which is home.)

*May be convened with 400-level course.

631. Indian Law (3) I (Identical with Law 631)
physics, biology, math through calculus, and biochemistry. Additional courses in advanced biology, advanced chemistry, genetics, molecular biology, and statistics are recommended. In addition, applicants must submit scores from the aptitude test of the Graduate Record Exam (GRE); submission of the score on one of the advanced tests is optional. Application requirements also include 3 letters of recommendation from former science instructors and a statement of career goals.

The program of study is very flexible with only one required lecture course (ANAT 577), two laboratory rotations, and a research presentation every year. Each student selects a personalized program of additional course work and study with guidance and approval from the student's dissertation advisor and members of the dissertation committee. Students are required to take a total of 36 units in anatomy, 18 of which must be obtained from graded (A, B, C, etc.) courses. Students are required to teach one semester as part of their training. Students in anatomy must also select a minor field and fulfill the requirements of that department for the minor. Doctoral students majoring in other disciplines may select anatomy as a minor field of study. The minor program must consist of 9 units in anatomy, 5 of which must be obtained from graded (A, B, C etc.) courses, and approval from an anatomy minor advisor who serves on the dissertation committee.

595. Colloquium

595d) II 1993-94 (Identical with CBIO 696d)

596. Seminar

596a. Research Group Discussion (1) I II [Rpt./14] Open to majors only. Consult instructor before registering.

597. Workshop


603. Microscopic Structure (1-3) I II Selected concepts of structural organization at light and electron microscopic levels of the anatomy and development of the cells, tissues, and organs of vertebrates. P, 601, 602.

604. Gross Human Anatomy (2-6) I II Study in depth of the gross human anatomy of selected areas or systems. P, 601, 602. Consult department before registering.

605. Human Neuroscience (6) I II Functional and morphological organization of the human CNS. Permission required to enroll; consult instructor before registering. Course begins in October and extends through March. (Identical with NEUR 605, PHCL 605, and PSIO 605)


606-610b. Anatomical Techniques (1 to 4) I II Introduction to special techniques and procedures of analytical anatomy. P, 601, 602; consult department before enrolling.


611. Introduction to Anatomical Literature (1) I II A problem-oriented, bibliographic approach to basic anatomical references. Primarily for those students planning a career in anatomy and wishing to prepare themselves for further graduate study. 3L.


616. Introduction to Anatomical Literature (1) I II A problem-oriented, bibliographic approach to basic anatomical references. Primarily for those students planning a career in anatomy and wishing to prepare themselves for further graduate study. 3L.

697. Workshop


700. Laboratory Rotation (3) I II Rotations in the research laboratories of faculty in the Department of Anatomy. Consult instructor before registering.

801. Human Gross Anatomy (8) I Comprehensive survey of the development and gross structure of the human body. No grade is given until the full 8 units are completed.


805. Human Neuroscience (6) I II Morphological organization of the human central nervous system and neurotransmitters and intrinsic regulatory functions. (Identical with NEUR 805, PHCL 805, and PSIO 805)
A minimum of 30 graduate units are required for the degree. At least one-half of the required units must be in courses in which regular grades (A, B, C) have been earned. Students must complete three units of statistics, three units of biochemistry, three units of physiology, and two units of seminar. Additional requirements for completion of the degree will be determined by the major professor and graduate advisory committee.

**Doctor of Philosophy:** Students are required to provide scores for the Graduate Record Exam (GRE) and should request that the information be sent directly to the Animal Sciences Department. In addition to the regular portion of the examination (Quantitative, Analytical, and Verbal), advanced examination in either biology or chemistry is recommended but not required.

Students are usually admitted to the Ph.D. program after completing the master's degree. A B.S. or B.A. and M.S. degree in animal, biological, chemical or physical sciences is recommended. (The M.S. requirement may be waived for unusually well qualified candidates.)

At least 36 units of graduate credit exclusive of dissertation credits are required for the major. Students must meet the minimum requirements established for the master's degree in animal sciences. Additional required graduate credit units are three units of statistical design; three units of biochemistry; two units of animal growth, endocrinology or physiology; and two units of seminar. At least nine units of graduate courses, depending upon the requirements of the minor department, are required for the minor. A minimum of 18 units of dissertation is required. A maximum of 10 units of individual studies (599, 699, 900) plus seminar credits will be allowed toward the Ph.D. requirements. Additional requirements for completion of the degree will be determined by the major professor and student's graduate advisory committee but must include a minimum of six units from at least two of the following: AN S 501, 513, 585, 586, 601, 609, 622, 635, 636, 637, 684, 687.

**Animal Growth and Development (2)** I II 1994-95 Growth and development of domestic animals, with emphasis on skeletal muscle, bone and adipose tissue growth, from the cellular level to the whole animal. P, BIOC 460 or 462a.

**Population Genetics:** I 1994-95 Theoretical and mathematical aspects of population genetics. P, BIOC 460 or 462a.

**501. Animal Growth and Development (2)** I II 1994-95 Growth and development of domestic animals, with emphasis on skeletal muscle, bone and adipose tissue growth, from the cellular level to the whole animal. P, BIOC 460 or 462a.

**513. Quantitative Genetics (3)** I 1994-95 Theory of quantitative genetics including idealized populations, forces that change gene frequency, breeding systems, and estimation of genetic parameters in a population. P, 6 units of genetics. (Identical with GENE 513)

**520. Pathways and Signals in Cells (3)** II (Identical with BIOC 520)


**535. Biotechnology in Animal Sciences (3)** I 1994-95 Survey of current recombinant DNA technology and principles. Topics include: vectors and hosts, enzymes used in molecular cloning, DNA sequencing, site-directed mutagenesis, expression systems and polymerase chain reaction. P, BIOC 460 or 462a.

**543. Research Animal Methods (3)** I (Identical with V SC 543)

**585. Domestic Animal Endocrinology (3)** I 1994-95 Endocrine regulation of growth, metabolism and reproduction of domestic farm animals. P, 3 units of biochemistry.

**586. Physiology of Lactation and Neonatal Development (2)** I II 1994-95 The anatomical and physiological mechanisms governing the process of milk secretion and neonatal development. P, 415R.

**596. Seminar (3)** I II a. Animal Sciences (1) [Rpt./3] I II


**609. Nutritional Biochemistry Techniques (3)** I II (Identical with N FS 609)

**612. Biological Electron Microscopy (3)** I (Identical with MCB 612)

**615. Chemistry and Metabolism of Lipids (3)** II 1993-94 (Identical with N FS 615)

**622. Mineral Metabolism (2)** I 1993-94 (Identical with N FS 622)

**635. Ruminant Nutrition (3)** I Recent findings in ruminant nutrition; the physiochemical processes of digestion and absorption; importance and metabolism of rumen microflora; normal metabolism and abnormal metabolic disorders; modes of action of feed stimulants. P, 330, 336; CHEM 241a, 243a.


**665. Analysis and Purification of Proteins (3)** II 1993-94 Principles and procedures for analyzing, purifying, and characterizing proteins and amino acids from cells or from cDNA ex-
pression systems. P, BIOC 462a preferred, BIOC 460 acceptable. (Identical with BIOC 665 and NPS 665)

684. Animal Physiology Research Techniques (2) I 1993-94 Introduction to selected physiological and biochemical techniques used in animal research. 1R, 3L. Open to majors only. P, BIOC 460 or 462a.

687. Environmental Physiology of Domestic Animals (3) II 1993-94 Physiological, behavioral and anatomical responses of domestic animals to their environment, with emphasis on adaptive mechanisms. P, 413, 415R, 430, 3 units of general physiology/anatomy.

696. Seminar
a. Animal Sciences (1) [Rpt./3 units] II

Anthropology (ANTH)

Anthropology Building, Room 210 (602) 621-2585


Associate Professors Constance Cronin, Mark A. Nichte, John W. Olsen, Thomas K. Park, Richard A. Thompson, Brackete F. Williams

Assistant Professors Ana Alonso, Marcia C. Inhorn, David J. Killick, Barbara J. Mills, Daniel Nugent, Willem J. de Reuse

The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees with a major in anthropology. Concentrations are available in archaeology, cultural anthropology, linguistics, or physical anthropology.

Each applicant is required to submit scores on the aptitude test of the Graduate Record Examination taken within the last five years, a detailed statement of professional goals, and two letters of recommendation from instructors who are in a position to predict the applicant's potential as a graduate student.

Degrees

Master of Arts: No thesis is required. A minimum of twelve units in anthropological core courses and eighteen units in supporting work must be completed. Supporting courses may be chosen from Southwest studies, applied anthropology, American Indian studies, cultural resource management, museology, secondary education, archaeology, cultural anthropology, linguistics, physical anthropology, or general anthropology. Specific course requirements for programs in cultural resource management, forensic anthropology, medical anthropology, and museology are listed in literature available from departmental advisors.

Doctor of Philosophy: The major consists of 36 or more units of course work plus the dissertation. The minor, consisting of fifteen or more units, may be taken within the department. Special requirements include reading knowledge of a foreign language and a working knowledge of modern statistical methods.

The Bureau of Applied Research in Anthropology, a division of the Department of Anthropology, is a regional and international center for basic and applied research relating to culture change, urban and rural living, technological innovation, demography, and cross-cultural management. Extensive archaeological, ethnological, and osteological collections are available in the Arizona State Museum. Field training in archaeological techniques is offered on both the graduate and undergraduate levels at the University of Arizona Archaeological Field School, which is operated jointly by the department and the Arizona State Museum. The Laboratories of Tree-Ring Research, Isotope Geochemistry, Paleoenvironmental Studies, and Palaeontology provide opportunities for climatic and chronological studies of special interest to advanced students in archaeology.

500.* Processes of Culture Change (3) II In-depth investigation of specific theories and varieties of culture change. P, 200.

501.* Ancient Mesopotamia (3) I 1994-95 Sumerian, Babylonian, and Assyrian civilization from the first cuneiform documents to the fall of the neo-Babylonian empire, with special attention to issues of sociopolitical organization. P, NES 171, ANTH 101, 110 or consult department before enrollment. (Identical with HIST 501 and NES 501)

502a-502b. Dynamics of Indian Societies (3-3) (Identical with AINS 502a-502b)

503.* Anthropology of Conflict Resolution (3) II Decision making, conflict, and violence from a cross-cultural perspective, aiming to build both understanding of conflict processes and skills for managing and resolving them.

505.* Urban Adaptation of Ethnic Groups (3) I A survey of adaptations of ethnic and social groups to urban areas, focusing on a different group or region each semester.

506.* Gender and Social Identity (3) II An analysis of the social and cultural construction of gender across cultures. Emphasis will be on preindustrial societies, using data to test theories of gender.

507.* Bilingualism in the Southwest (3) I II Historical background and theoretical issues dealing with linguistic minority groups in the Southwest. Field trip. (Identical with MAS 507)

508.* Anthropology and Public Policy (3) II Examines the development, goals, techniques, and practices of anthropology as a policy science.

509.* Economic Anthropology (3) II Analysis of production, exchange, distribution, consumption, property, economic surplus, inheritance, and types of economic structure. P, 200, or 12 units of economics. (Identical with ECON 509 and LA S 509)

510.* Ceramic Ethnoarchaeology (3) II 1993-94 Using ethnoarchaeological and ethnographic case studies from diverse geographical areas, the course examines relationships between ceramics and a range of matters traditionally of interest to archaeologists.

511.* Anthropology of Religion (3) I Comparative approaches to the study of religion, systems of ritual and symbolism in the primitive world; shamanism and possession; religious movements; religion in the modern world.

512.* Peasants and Peasant Societies (3) II 1993-94 Comparison of approaches to analyzing the peasantry. Special concern with peasant political mobilization and consciousness. Research-Writing-Emphasis Course.

513.* Ethnology of the Southwest (3) II Culture history and economic, social, and religious institutions of the living people of the Southwest. P, 200. (Identical with AINS 513)

514. Late Quaternary Geology (3) I (Identical with GEOS 514)

515. Cultural Ecology of Agrarian Societies in the Middle East (3) I 1994-95 Emphasis is on land tenure, Islamic law, irrigation and agricultural development in the central Middle East, Nile valley, North Africa, and the Sahel from the Middle Ages to the present.

516.* Contemporary Indian America (3) II 1994-95 The historical development and contemporary significance of the reservation system in the life of the Native American of the United States. (Identical with AINS 516)

517.* Cultures of Ancient Mexico (3) S Archaeological and ethnographic survey of the civilizations of ancient Mexico from earliest times to the period of the Spanish Conquest. Field trips. (Identical with LA S 517)

519.* Psychological Anthropology (3) II Cultural emphasis and experiences as basic shaping forces in personal development and emotion. Topics include psychoanalysis and anthropology, gender and sexuality, childhood, grief and mourning, dreaming, psycho-pathology. P, 102, 200.
covaries, case studies, hypothesis on the people of the Americas. Field trip. (Identical with Geos 561)

562. Archaeological Quantitative Methods (3) I 1994-95 Intensive review of the theory and application of statistical and mathematical methods to archaeological data.

563. Evolution of Ancient States and Civilizations (3) I 1993-94 Classical and modern theories used to explain the rise of ancient states and civilizations are evaluated as systems of anthropological logic and for their ability to elucidate the archaeological record. Major topics include the nature of growth trajectories, variability in ancient states, the collapse of states, and constraints of growth in selected areas of the world. P, consult department before enrolling.

564. * Introduction to Dendrochronology (4) (Identical with GEOS 564)

565. * Women in International Development (3) II 1994-95 The impact of international development on women as agricultural producers, householders, migrants, workers in formal/informal labor markets and participants in planned change. (Identical with FCR 565 and LA 5 565)

566. * Paleoanthropology (3) I Evidence for human and nonhuman primate evolution including laboratory study of fossil casts and modern skeletal biology. P, 265 or consult department before enrolling.

568. Human Osteology (4) I Human osteology for the archaeologist and physical anthropologist: techniques of in situ and laboratory identification, preservation and measurement. P, consult department before enrolling.

570a-570b. * Human Adaptability (3-3) Study of the means by which humans adjust to their environments through the processes of growth and development. Focus is on physiological, nutritional, and epidemiological factors. 570a includes discussion of the biology of human aging. P, 265 or consult department before enrolling. 570a is not prerequisite to 570b. (570a is identical with GEO 570a) 570a-570b.

571a-571b. Applied Medical Anthropology in Western Contexts (3-3) 1993-94 Investigations of the illness experience; symbolic interpretations of medicines and medical procedures; doctor-patient communications and illness narratives. 571a demonstrates the applicability of major social science theories in the related study of health-related behavior. 571b focuses on methods of data collection and presents case studies illustrating the application of methods in the study of designated health problem areas, interviewer transference and issues of reflexivity. P, 536a.


573. * Primate Anatomy (4) I Comparative primate functional anatomy from an anthropological viewpoint including extensive laboratory dissection and study of behavior, ecology, and evolution. P, 265 or consult department before enrolling.

575. * Language in Culture (3) II Survey of the nature of the interrelationships between language and other cultural phenomena. P, LIN 101 or ANTH 276 (Identical with LING 576)

577. * Discourse and Text (3) I 1993-94 Analysis and cross-cultural comparison of patterns of communication in discourse; modern approaches to discourse and text. P, LIN 101 or ANTH 276 (Identical with LING 577)

578. * Archaeological Analysis with Geographic Information Systems (3) I 1994-95 An overview of computer concepts, techniques, and algorithms fundamental to Geographic Information Systems (GIS). Emphasis is placed on the use of GIS to examine, analyze, and model archaeological and environmental distributions within areas of study.

579. * Culture and Materials Technology (3) I Investigates the ways in which systems of technology are embedded in a cultural context and the resulting impacts on invention, innovation and conservation, technology transfer, and cultural change. (Identical with MSE 579)

580. * Historical Comparative Linguistics (3) I Types and mechanisms of linguistic change; language and dialect formation; determinations of prehistoric connections; reconstructions of proto-languages and cultures, and their origins in time and space. P, 276 or LIN 101 (Identical with LING 580)

581. Quaternary Palynology (4) I II 1993-94 (Identical with GEOS 581)

582. * Hopi Language in Culture (3) I II A conversational introduction to Third Mesa dialect of Hopi, with emphasis on cultural context and covering essentials of Hopi language structure. (Identical with AINS 582)

583. Sociolinguistics (3) I Contributions of the ethnography of communication, language variation studies, and conversation/discourse analysis to the interdisciplinary development of sociolinguistics. (Identical with LING 583)

584a-584b. Akkadain Linguistics (3-3) I II Introduction to the standard literary language of the Babylonians and Assyrians. (Identical with NES 584a-584b)

585. * Social Organization of India and Pakistan (5) I (Identical with NES 585)

587. * Poverty and Health (3) II (Identical with NURS 587)

588. * Clinical Anthropology (3) I II (Identical with NURS 588)

590. * Women in Middle Eastern Society (3) I Middle Eastern society viewed from the perspective of women. Examines the extent to which formal definitions of women’s nature and roles coincide with women’s self-images and activities. (Identical with NES 590)

596. Seminar

a. Pre-Columbian and Paleolithic Archaeology of Africa (3) I II 1994-95, P, introductory and upper-division courses in archaeology and physical anthropology.

c. The Dynamics of Human Subsistence (3) I II 1993-94

e. Pre-Columbian Art (3) (Rpt./4) I (Identical with AR H 596c, which is home)

f. Ceramic Analysis (3) I II 1994-95

h. Experimental Archaeology (3) I 1993-94

k. Risk and Society (3) (Rpt./6 units) I (Identical with GEOG 596k, which is home)

q. Near Eastern Archaeology (3) (Rpt.) I II (Identical with NES 596c, which is home)

r. Quaternary Geochronology (1-4) I II (Identical with GEOS 596r, which is home)

597. Workshop

a. Physical and Forensic Anthropology I (2) (Rpt.) I Consult dept. before enrolling.

b. Physical and Forensic Anthropology II (2) (Rpt.) I II Consult dept. before enrolling.

c. Dendrochronology (2) (3) (Identical with GEOS 597c, which is home)

*May be convened with 400-level course.

600. Survey of Cultural Anthropology (3) I Intensive introduction, overview, and synthesis of cultural anthropology.

606. Women’s Health in the United States (3) II 1994-95 An examination of social, cultural and political-economic factors affecting women’s health in historical and contemporary contexts in the U.S. Focus on anthropological and feminist perspectives. (Identical with WS 606)

607. Anthropological Research Methods and Design (3) I Survey of research designs, data collection methods, and data analysis used in ethnographic field research by sociocultural and medical anthropologists. Focus on practical skill acquisition.

608. History of Anthropological Theory (3) I Survey of the foundations of contemporary theory in the field of cultural anthropology.

631. Anthropology and Development (3) I II 1994-95 The role of anthropology in interdisciplinary projects involving economic development and planned change on the national and international levels. (Identical with AR L 631 and LA S 631)

636. Foundations of Archaeological Interpretation (3) I Surveys the history of archaeological interpretation. Central concepts in archaeological method and theory are presented. Open only to graduate students with a concentration in archaeology.

642a-642b. Advanced Field Course in Archaeology (3-3) S Archaeological methods, theory, and field techniques. 642a: Three-week field excavation and survey. Fee. 642b: Three-week laboratory processing and analysis. Fee. Registration restricted. Contact department for application, which must be returned by April 1.

645. Early Civilizations (3) (Rpt./2) II 1993-94 Comparative analysis of early civilizations from both the Old World and the New World, with emphasis on regularities in cultural development. P, 454, 456, 457, or 456a or 456b.
665. Survey of Physical Anthropology (3) II
Modern physical anthropology including evolutionary theory, genetics, skeletal biology, primatology, paleoanthropology, human growth, adaptability and demography.

666. Human Microevolution (3) II [Rpt.] 1994-95 Problems and methodology in the study of cultural, demographic, and ecological factors affecting microevolutionary processes in human populations. P. 685. (Identical with GENE 666)

675a-675b. Anthropology and International Health (3-3) 1994-95 675a: An intensive overview of the field of international health and anthropologists' contributions to it. Responses to biotechnology, primary health care and child survival, diseases and development; health care utilization patterns; world systems and multinational pharmaceutical industry; health care bureaucracies; interaction between traditional medicine and public health. 675b: Health transitions and the household production of health with emphasis on anthropological investigations of health within a broader development context. P. 536a.

679. Language and Ethnography (3) II Training in the use of ethnographic method in linguistic and cultural research where naturally occurring speech is data. Analysis of data from observation, tape recording and video-taping.

680. Survey of Linguistic Anthropology (3) II Major theoretical and methodological issues in linguistic analysis. Language as a cultural code, biological foundations, universal and typology, language and social reality, textual analysis.

695. Colloquium
a. Forensic Anthropology (2) [Rpt./6 units] II 2R, 1L. P or CR. 468 and 597b.

696. Seminar
a. Archaeology (1-3) [Rpt./3] II
b. Cultural Anthropology (1-3) [Rpt./3] I II (Identical with AR L 696b and NES 696b)
c. Linguistic Anthropology (1-3) [Rpt./3] I II

Applied Mathematics (APPL)
Mathematics Building, Room 414 (602) 621-4664
Graduate Interdisciplinary Program in Applied Mathematics
Committee:
Professors Michael Tabor, Head (Applied Mathematics), David W. Arnett (Physics), Thomas F. Balsa (Aerospace and Mechanical Engineering), Harrison H. Barrett (Optical Sciences), Jim M. Cushing (Mathematics), William J. Dallas (Radiology), Donald G. Dudley (Electrical and Computer Engineering), William G. Faris (Mathematics), Hermann Fasel (Aerospace and Mechanical Engineering), Hermann Flaschka (Mathematics), W. Martin Greenlee (Mathematics), William B. Hubbard (Lunar and Planetary Sciences), Bobby R. Hunt (Electrical and Computer Engineering), C. David Levermore (Mathematics), David O. Lomen (Mathematics), Pierre Meystre (Optical Sciences Center), Richard E. Michod (Ecology and Evolutionary Biology), Jerome V. Moloney (Mathematics), Donald E. Myers (Mathematics), Michael F. Neuts (Systems and Industrial Engineering), Alan C. Newell (Mathematics), Adrian N. Patrascoiu (Physics), Robert B. Roemer (Aerospace and Mechanical Engineering), William M. Schaffer (Ecology and Evolutionary Biology), Alwyn C. Scott (Mathematics), Moshe Shaked (Mathematics), Thomas L. Vincent (Aerospace and Mechanical Engineering), Arthur T. Winfree (Ecology and Evolutionary Biology)

Associate Professors
Bruce J. Bayly (Mathematics), Moisey Brío (Mathematics), Kwok Wing Chow (Mathematics), Joseph A. Zehnder (Atmospheric Sciences)

A list of affiliate members is available upon request.

The Program in Applied Mathematics offers courses of study leading to the Master of Science and Doctor of Philosophy degrees. It supports and encourages research in many areas of mathematical, physical, biological, and engineering sciences in which the use and development of mathematical methods and modeling techniques play a central role.

Students entering the program are expected to have a strong background in mathematics including advanced calculus, complex variables and differential equations. However, entry into the program is not restricted to students who have an undergraduate mathematics major. Courses of study in the program are flexible and individually designed. In the first year, students take a sequence of core courses offered in conjunction with the Department of Mathematics, which includes numerical analysis, principles of analysis, and methods of applied mathematics. In addition, students attend a series of weekly case studies in which members of the program describe recent or current research work. Subsequent years students are able to choose from a broad variety of courses suited to their evolving research interests.

For the Doctor of Philosophy degree a dissertation is required. This dissertation is expected to contain original contributions by the student to the solution of a mathematical problem in a scientific discipline, or to the development of applicable mathematical methods and/or modeling techniques.

The listed members of the program are actively involved in the supervision and/or teaching of program graduate students. The departmental affiliations of the faculty in this list give an indication of the breadth of research activities. In addition, the program has a substantial body of affiliate members who are involved in research with a strong applied mathematics component and who are potential research advisors. The combined network of members and affiliate members creates an unusually broad base of interdisciplinary research opportunities in applied mathematics.

Arabic
(See Near Eastern Studies)

Architecture (ARCH)
Architecture Building, Room 104 (602) 621-6751
Associate Professors Harry de Bohogian, Nader V. Chalfloun, Dennis Doxlater, Robert W. Dvorak, Charles Paster
Assistant Professors Dominique Bonnamour-Lloyd, Richard A. Ebeltoft, Abigail Van Slyck

The College of Architecture offers a program leading to the second professional degree, Master of Architecture. For information concerning this degree program, see Requirements for Master's Degrees/Master of Architecture elsewhere in this catalog.
42 Architecture—Arid Lands Resource Sciences


502.* Topics in Architectural Design (6) Studio work emphasizing design of large buildings or building complexes in one of the following: building design, urban design, campus design, design competitions, computer-aided design. Offerings are limited by faculty availability, and all topics may not be offered each year. Other topics may be introduced. Fee. P, 401.

503.* Solar Utilization in the Built Environment (3) I Survey of solar energy utilization principles, methods and case studies focused upon building and site planning design.

504.* Architecture and Planning in Mexico (3) I Study of architectural development in Mexico during the prehispanic, Spanish colonial and contemporary periods, with emphasis on design ideas from each period. (Identical with LA 504)

512.* Topics in Design Communication (3) I [Rpt. 2] Directed studies in advanced design communications. Topics vary. Selected topics may include rendering, design publications, public relations, portfolio preparation. Other topics may be introduced. P, 222, 301.

513.* Architecture and the Arid Region (2) I Studies of the relationship between architecture and the climatic characteristics of arid regions with emphasis on passive cooling techniques. P, 302.

514.* History of American Architecture (3) II Developments in American architecture from the colonial to the early modern period. P, 6 units of art history or architectural history. Nonmajors may petition to enroll.

522.* Urban Communication (3) I I [Rpt. /6 units] II Study of design communication in urban settings including perception, way finding and systems of signage. Class project of a specific urban area required. F, 202, 301.


527.* Field Methods in Environmental Psychology (3) II (Identical with PSYC 527)

532.* Video and Media in Design Communication (3) I Introduction to video and other media in architectural design communication, with emphasis on photographic reproduction, graphic design, desktop publishing, slide photography, slide presentations, and video production. Personal presentations based upon communication psychology and theory.

533.* Lightweight Construction Techniques (3) I Survey of lightweight construction techniques, including pneumatics, tensile membranes, three-dimensional cable nets, grid shells and flexure stiff plates.

534.* History of the American House (3) I Survey of American domestic buildings from European settlement to the present including social, political, and economic forces affecting architectural change. P, 201 admission to professional phase.


542.* Architectural Photography (3) I Theory and practical techniques for the varied use of photography in the field. Emphasis on the "daily use" of 35mm equipment and color slide films for self expression, documentation (exteriors/internals), copywork, scale models and simulation. Introductory hands-on exploration of large format photography with polaroid film.

543.* Architecture in the Mediterranean (3) I Summer study tour of the Mediterranean focusing on architecture. Includes Greece and the Greek islands. Seminars and graphic and written projects and assignments. Emphasis on field investigation.

544.* Site Planning (2) II Studies relating to design determinants for development of outdoor space. Lectures and exercises dealing with individual design criticism including topography, hydrology, climate, and vegetation. Final project summarizing and applying all criteria to a realistic development project is required. P, 302.

551.* Emphasis Areas in Architecture (6) I Studio work emphasizing one of the following: desert architecture, community design, historic preservation, design communication, computer-aided design, entrepreneurial design, architectural programming and evaluation. Offerings are limited by faculty availability, and all topics may not be offered each year. Other topics may be introduced. P, 334, 335, 336, 402, 428.

559.* Ethics and Practice (3) I Standards and values of architectural services and professional project and practice management. P, 270 and 402.

562.* Design Communications (3) I Design communication. P, 402.


570.* Computer Graphics in Architecture (3) I Introduction to the theory, techniques, and applications of computer-aided design, centering on computers in the design process using two and three dimensional graphics to represent architectural data bases. Lectures and seminars on technical topics, plus intensive experience on graphic work stations. P, 270 and 202.

573.* Introduction to the Conservation of Cultural Resources (3) I An overview of the Historic Preservation movement in America, including discussion of concepts, rationale for and methods of resource utilization, implementation of plans, legislation, etc. Field trips.

580.* Computer Applications in Architecture (3) I Introduction to the theory, techniques, and applications of computer-based architectural presentations and color renderings. Focusing on generating photo realistic architectural images and fly-throughs that are assembled in a finished multimedia presentation. Intensive experience on graphic work stations. P, 470.


584.* Planning the Built Environment (2) I A lecture survey dealing with the origins and implications of the physical manifestations of communal ordering systems. An analytic vocabulary is developed with which current and historic settlement patterns are visually compared to discover spatial attributes as a dimension of human experience. P, 302 and 334. (Identical with PLNG 584)

585.* Space: A Social-Cultural View (3) [Rpt. /1] I Human, socio-cultural use of space including processes of symbolic expression. Investigation of the role of space through ethnographic readings describing both ritual and architectural examples. Consult department before enrolling.

596. Seminar
   a. Readings in Architectural Theory (2-4)
   [Rpt.] I II Open to non-majors.
   b. Interdisciplinary Environment-Behavior-Design (3) I (Identical with ENV 596a, which is home)

597. Workshop
   a. Architecture (1-3) [Rpt. /6 units] II I II Open to non-majors. (Identical with PLNG 597a)
   b. Special Projects in Architecture (1-3) [Rpt. /6 units] I II I I II 5 Consult college before enrolling.
   i. Community Design for Non-Designers (3) I Field trips. Open to nonmajors only. (Identical with L AR 597i and PLNG 597i)

   *May be conceived with 400-level course.

696. Seminar
   a. Financing Public Services (3) I (Identical with PLNG 696b)

Arid Lands Resource Sciences (AR L)
845 N. Park Avenue, Room 102
(602) 621-1955
Graduate Interdisciplinary Program in Arid Lands Resource Sciences
Committee:
Professors Paul G. Bartels (Plant Sciences), Robert B. Bechtel (Psychol-
tained locally without external support. Tools upon which the track draws from many disciplines including agricultural economics, agronomy, applied anthropology, applied ecology, range science, soil science, and watershed management.

Ethnoecological studies focus on the interaction between humans and their physical and biological environment. The ethnoecological track draws heavily on several disciplines or traditions within disciplines, including anthropology (ethnology, archaeology, ethnobotany), geography (human ecology), ecology (botany), and plant sciences (economic botany).

Physical studies focus on the interaction of two or more of the physical elements of the environment. Climate is usually one of those elements. The physical studies track draws on the earth sciences including atmospheric sciences, geosciences, hydrology, watershed management and those parts of engineering, economics, and architecture that are concerned with large and enduring transformations of the arid landscape.

Application materials are available from the department. All applicants must provide the following directly to the department: General Graduate Record Examination scores, three letters of recommendation, a list of publications and special papers, curriculum vitae, personal resume, proposed study program, and a brief statement of long range professional plans. Interested students should request additional information from the program chairman. Doctoral students with majors in other fields may use arid lands resource sciences as a minor field.

512. Economic Policy in Developing Countries (3) (Identical with AREC 512).
513. Physical Climatology (3) II (Identical with ATM 512).
523. Hydrology (3) I (Identical with C E 523).
531. Anthropology and Development (3) II (Identical with ANTH 531).
535. Water Management in Dryland Ecosystems (3) I (Identical with WS M 535).
564. The Arid and Semiarid Lands (3) I (Identical with AREC 564).
565. Physical Aspects of Arid Lands (3) II (Identical with GEOS 565).
575. Economics of Natural Resource Policy (3) I (Identical with AREC 575).

595. Colloquium
a. Current Research (1) [Rpt./8 units] I II
596. Seminar
a. Physical and Biological Characteristics of Arid Lands (3) [Rpt./6 units] I 1993-94
b. Use and Management of Arid Lands (3) [Rpt./6 units] II 1993-94
c. Cultures and Institutions of Arid Lands (3) [Rpt./6 units] I 1994-95
d. Current Topics in Arid Land Research (3) [Rpt./6 units] II 1994-95
696. Seminar
b. Cultural Anthropology (1-3) [Rpt./3] I II (Identical with ANTH 696b, which is home)

Art (ART/ARE/ARH)
Art Building, Room 104
(602) 621-7570


Associate Professors Rosemarie T. Bernardi, Jerold Bishop, Jackson Boelts, Aurore Chabot, John F. Heric, Harold H. Jones, D. Keith McElroy, Bart J. Morse, Mikelle Omani, Andrew Polk, Kenneth Shorr, Robert P. Tobias

Assistant Professors Jeannette M. Carrigan, David Christiana, Pia Cuneo, Lynn Galbraith, Paul Ivey, Ellen McMahon, Barbara Penn, Shelli Pitt, Julie Plax, Alfred Quiroz, Joyan Saunders, Stacie C. Widdlfeld, Jane Welch Williams

Degrees
Master of Fine Arts: Concentrations are available in painting, drawing, sculpture, the print processes, ceramics, metalwork, graphic design, photography, fibers and combined media. For further information concerning this degree see Requirements for Master's Degrees/Master of Fine Arts elsewhere in this catalog.

Master of Arts (major in art history): Applicants may be admitted with 18 units of undergraduate credit in art history or with 12 such units plus a substantial amount of credit in related areas of study.

The Master of Arts with a major in art history requires a minimum of 30 units in art history, including three units of 511, six units of 596, and three to six...
units of 910. With the approval of the advisor, other courses may be substituted for a portion of the 24-unit art history requirement. A maximum of 9 units may be in individual studies including 900 and 910. A reading knowledge of French or German or other approved language must be demonstrated before the Comprehensive Examination may be taken and the Comprehensive Examination be passed prior to undertaking thesis work. The Comprehensive Examination may be taken no more than twice. A thesis is required.

A concentration in museum studies is available. For further information contact the Art Department.

Master of Arts (major in art education) is a 30-unit program which encourages students to individualize their studies with courses from other subject disciplines such as art history, art therapy, studio art, education, and other related fields.

All students must complete at least 15 units in art education course work, including courses in research methods and current issues upon approval of their art education advisor. Other graduate-level courses on selected art education topics will be offered each semester.

Requirements for entry into the graduate art education program include: an undergraduate degree in art, education, psychology, or other related field; three letters of recommendation sent directly to the Art Education office; a written autobiographical statement; a current resume, and evidence of scholarship and/or studio work. Further documentation may be requested.

Special facilities for graduate work include the works devoted to art within the T. E. Hanley Collection of 37,000 volumes; the Samuel H. Kress Collection of 14th to 19th Century European art, including the surviving panels of the Retablo of Ciudad Rodrigo by Fernando Gallego; the Charles Leonard Pfeiffer Collection of American art, consisting of more than 100 contemporary American paintings; the Edward Joseph Gallagher III Memorial Collection of contemporary American paintings and European, Latin American, and Oriental objects of art; and miscellaneous collections, including the University Print Collection of notable examples of various graphic arts. The Center for Creative Photography houses 50,000 photographic prints, archives of negatives, correspondence and memorabilia as well as a specialized library of over 12,000 volumes. The University of Arizona Museum of Art schedules exhibitions from these collections and, from time to time, other exhibitions of general or special interest.

Studio Art (ART)

505. Graduate Figure Drawing (3) [Rpt./5] I II Special problems in drawing, using the classroom model and outside sources as references for personal expression. 65. Fee.

509. Graduate Drawing Critique (3) [Rpt./5] I II Individual exploration in drawing media and visual concepts. Classroom and individual critiques.


546.* Experimental Color Photography (3) [Rpt./1] I Nontraditional approaches to color photography including the use of black-and-white and color negatives, manipulation of the negative, dyes and paints added to the print. Development of personal vision encouraged. 2R, 25. Fee. P, 241; 341a, 341b or 341c; 346, acceptance by portfolio.

547.* Mixed Media Book (3) [Rpt./1] I II Investigation of the book as a format for presenting visual material, the process of making simple books. Contemporary bookmakers will be presented. 2R, 25. Fee. P, 241; 341a, 341b or 341c; 346, acceptance by portfolio.

549.* Advanced Artists' Video (3) [Rpt./1] I II Students will produce individual video projects with an experimental, self-expression orientation. There is also an option to combine video with performance or to incorporate it within an installation context. P, portfolio review and ART 349 or M AR 314.

550. Graduate Relief Printmaking (3) [Rpt./1] I II Relief printmaking with emphasis on individual research, personal direction and professional standards. 65. Fee.

551. Graduate Intaglio (3) I II Intaglio printmaking with emphasis on individual research, personal direction and professional standards. 65. Fee.

553. Graduate Alternative Methods in Printmaking (3) I II Nontraditional approaches to printmaking with emphasis on individual research, personal direction and professional standards. 65. Fee.

555. Graduate Lithography (3) I II Lithography with emphasis on individual research, personal aesthetic, and professional standards. 65. Fee.

565. Graduate Graphic Design Problems (3) [Rpt./1] I II Two- and three-dimensional designs considerations with emphasis on conceptualization and presentation. 65. Field trips. Fee. P, acceptance of portfolio.

566.* Editorial Illustration (3) [Rpt./1] I Problems in editorial and book illustration. 65. Fee. P, 9 units of illustration courses and approval of portfolio.

567. Graduate Illustration (3) [Rpt./1] I II Exploration of any optical material or phenomenon as a possible solution to illustration problems. 65. Fee. P, 466, acceptance of portfolio.

569.* Portfolio Preparation (3) [Rpt./1] I II Final approach to completion of portfolio. Student's portfolio is critiqued in areas of order, style, and degree of presentation to bring it to a professional level. 65. Fee. P, 9 units of graphic design courses and approval of portfolio.

571.* Advanced Jewelry and Metal Smithing I (3) [Rpt./4] I Advanced study of the various materials and methods in the construction of jewelry and metalwork. 65. Fee. P, 9 units of metalwork.

572.* Advanced Jewelry and Metal Smithing II (3) [Rpt./1] I II Advanced problems in design and execution of jewelry and metalsmithing projects. Preparation of professional credentials including portfolio, photographing, rendering, exhibitions, and resumes. Fee. P, 471.

573.* Advanced Ceramics (3) [Rpt./5] I II Individual studio research and instruction, with emphasis on personal creative development. 1R, 45. Fee. P, 373, acceptance of portfolio by ceramic faculty.

576. Advanced Fibers (3) [Rpt./5] I II Individual interpretations of concept into finished fiber works.

578. Graduate Two-Dimensional Fiber Techniques (3) I Advanced fiber technique course for graduate students who wish to develop further their strengths in special technical areas. Stresses two-dimensional work. 65. P, consult department before enrolling.

579. Graduate Three-Dimensional Fiber Techniques (3) I Advanced fiber technique course for graduate students who wish to develop further their strengths in special technical areas. Stresses three-dimensional work. 65. P, consult department before enrolling.

580. Graduate Painting (3) [Rpt./5] I II Graduate study in painting with an emphasis on the development of a personal imagery and body of work.

582. Projects in Recent Art (3) [Rpt./6 units] I Advanced level study and studio application of contemporary art, ideas and practices, 1960 to the present. 65.

583.* Combining Media (3) [Rpt.] Individual and group projects, including collages, constructions, image sequences, and elements from other art forms (sound, language, movement, etc.).

585. Graduate Watercolor Painting (3) [Rpt./5] I II High level experimentation in personal expression with watercolor and related media. Demonstration and critique.

587a. Sculpture/ Casting Materials (3) [Rpt./3] I II An in-depth exploration of the techniques and concepts of casting. Advanced process of mold making as applied to individual directions. 65. Fee.

587b. Sculpture Materials/Metal and Wood Fabrication (3) [Rpt./3] I II An in-depth exploration of advanced processes and concepts of sculpture through metal and wood fabrication. 65. Fee.
Art Education (ARE)

500. Art for Exceptional Learners (3) Adaptation of structured art curricula to exceptional learner populations. P, course in art or special education.

530. Introduction to Research in Art Education (3) I II Development of competency in application of language, methods, and diverse research procedures used in the visual arts and education as demonstrated by a scholarly written research report.

531. The Teaching of Art (3) II Exploration of art education curricula and instructional methodology in the elementary school. P, TTE 300, EDUC 350; CR, 338L and 400.

532. Survey of Art Therapy (3) I Surveys the development of art therapy in the United States through examination of the literature, theories, and current trends in the field.


534. Art Therapy Techniques I (3) I Explores the use of art related projective assessments and art therapy treatment issues and techniques used with adolescents.

535. Art Therapy Techniques II (3) I Application of art therapy techniques used with adult populations, such as families and geriatric groups in a variety of treatment settings.

536. Seminar

a. Current Issues in Art Education Theory and Practice (3) [Rpt./12 units] II

*May be convened with 400-level course.

550. Painting Concepts (3) [Rpt./2 units] II 2R, 2S. Open to majors only.

551a. 3-D Concepts (3) [Rpt./3 units] II

552. Seminar

556. Graduate Printmaking (3) [Rpt./18 units] I II Printmaking with emphasis on aesthetics, conceptualization, technical competency, artistic literacy, and personal direction. 65. Fee. P, consult department before enrolling.

671. Graduate Jewelry and Metalsmithing (6-10) [Rpt./6 units] II Graduate study in all phases of jewelry and metalwork. 12 to 205.

672. Graduate Studio in Ceramics (3-10) [Rpt./6 units] I II 5 S Studio research and instruction with emphasis on personal creative development. 12 to 205. Field trips. Fee. P, 473.

673. Graduate Fiber Studies (6-10) [Rpt./6 units] I II Graduate experimentation in all aspects of fiber work, with emphasis on the development of a personal style within the medium. 12 to 205.

674. Graduate Studio (6-10) [Rpt./6 units] I II P, 12 units of graduate credit in art.

675. Graduate Problems in Sculpture (3) [Rpt./4 units] I II Emphasis on aesthetics, conceptualization, technical competency, artistic literacy, and personal direction. 65. Fee. P, consult department before enrolling.

Art History (ARH)

511. Methods of Art History (3) I Major intellectual approaches to the visual arts developed within the past 150 years. Field trips. Open to majors only.

512a-512b-512c-512d.* Medieval Art (3-3-3-3) The history of art and architecture in Western Europe and Byzantium between ca. 300 and ca. 1300. 512a: Early Christian and Byzantine Art. 512b: Early Medieval Art. 512c: Romanesque Art. 512d: Gothic Art. May be taken in any order. P, 6 units of history or art history.

513a-513b-513c.* Renaissance Art in Italy (3-3-3) Painting, sculpture and architecture in Italy. 513a: 13th-14th centuries. 513b: 15th century. 513c: 16th century. 513a is not prerequisite to 513b or 513c.

514a-514b.* Northern Renaissance Art (3-3) 514a: Development of Netherlandish painting during the late 14th through the 15th centuries. 514b: Art of the Reformation (16th century) in Germany and the Netherlands. P, 6 units of history or art history. 514a is not prerequisite to 514b.

517a-517b.* 19th-Century European Art (3-3) Painting and sculpture. 517a: From the French Revolution to about 1850. 517b: From about 1850 through Impressionism. P, 6 units of history or art history.

518a-518b.* 20th-Century Art (3-3) Painting and sculpture. 518a: 1888 to World War I. 518b: Between the World Wars. P, 6 units of history or art history. 518a is not prerequisite to 518b.

522a-522b.* Pre-Columbian Art (3-3) 522a: Art of the high cultures of Mesoamerica, with the focus on architecture, sculpture, painting and crafts prior to European contact. 522b: Pre-Columbian art of Central and South America, with particular attention to the Andean area. 522a is not prerequisite to 522b. (Identical with ANTH 522a-522b and LAS 522a-522b)

523a-523b.* The Art of Mexico (3-3) 523a: Art of Colonial Mexico, from the early 16th century to the late 18th century. The effects of the Spanish conquest on native traditions; public, private and sacred patronage; the effects of the Bourbon reforms. Painting, sculpture, architecture, graphic and minor arts. 523b: The art of Modern Mexico, from the late 18th century to the early 20th century. The Independence Period, the National Period, and the Revolutionary Period. Painting, sculpture, architecture, graphic and minor arts. 523a is not prerequisite to 523b.

524a-524b.* History of Photography (3-3) 524a: From its invention to 1895; Impact of photography on the art and culture of the 19th century. 524b: As an art medium from 1895 to 1965. P, 6 units of art history. 524a is not prerequisite to 524b.

529a-529b-529c-529d.* American Art (3-3-3) 529a: Art in the United States. 529a: Colonial art. 529b: 19th century art. 529c: From 1900 through 1940. 529d: Twentieth century American art from the 1930s to recent times. May be taken in any order. P, 6 units of history or art history.

534.* History of the American House (3) (Identical with ARCH 534)

535.* History of Prints (3) The technique and functions of the printmaking media from their inception in the 15th century to the present. P, ARH 117 or 118.

539a.* African Art (3) African art in context through chronological, interdisciplinary
Astronomy (ASTR) 949 N. Cherry Avenue, Room N204 (602) 621-2288


Associate Professors Willy Benz, John Bieging, William J. Cocke, Christopher Impey, Fulvio Melia, Andrez G. Pacholczyk, Marcia Rieke, Gary D. Schmidt, Raymond E. White

Assistant Professors Jill Bechtold, Christopher Walker

Associate Astronomers E. Keith Hege, Edward W. Olzewski

Project Scientist Robert N. Martin

Adjunct Astronomers Richard Green

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in astronomy. Specializations are available within the department in theoretical or observational astrophysics and in astronomical instrumentation. In addition, the Department of Planetary Sciences offers a concentration in solar system astronomy, and the Committee on Optical Sciences, through the Optical Sciences Center, offers advanced degrees and research in its own field of specialization. For further information see the Optical Sciences and Planetary Sciences elsewhere in this catalog.

In view of the heavy demand for admission to the graduate program, applicants are required to submit scores from the Graduate Record Examination (Aptitude and Advanced Test in Physics). Applications for financial aid must be supported by letters of recommendation. Undergraduate majors in physics, mathematics, or astronomy are preferred but exceptions may be made for applicants with other majors in special circumstances.

For the Master of Science degree, a written document but not a formal thesis is required. A final oral or written examination is required.

Successful completion of four of the eight "core" graduate courses (513, 518, 525, 528, 535, 540, 541, 545, and 582), as well as three graduate physics courses, is a prerequisite for more advanced graduate work in either the Master of Science or the Doctor of Philosophy program.

Doctoral students from other departments who elect to minor in astronomy must complete 12 acceptable graduate units in astronomy.

The facilities of the University of Arizona Observatories, which are associated with the Department of Astronomy, are available for student research. The 90-inch, 36-inch, and 20-inch reflecting telescopes are located at the Kitt Peak Observing Station, 48 miles southwest of Tucson and within the grounds of the Kitt Peak National Observatory. A dormitory and office building provide facilities for overnight and extended observing periods. The Steward Observatory, in collaboration with the Smithsonian Astrophysical Observatory, has constructed a 6-element Multiple Mirror Telescope equivalent in light gathering power to a conventional 176-inch telescope. Campus observing facilities include a 21-inch reflector, the 5-inch James refractor, and the Warner and Swasey transit instrument. The 7-inch Bailey photographic refractor is located on Tumamoc Hill, within a few minutes' drive of the campus. All telescopes have a wide range of modern auxiliary photometric, spectroscopic, and photographic equipment. The 90-inch telescope has, as well, TV acquisition and guidance systems and provision for computer-controlled telescope operation and data acquisition. The Observatory is developing on Mt. Graham a 10-meter telescope for work at mm and sub-mm wavelengths in collaboration with the Max Planck Institute for Radio Astronomy in Bonn, West Germany. The campus buildings provide lecture rooms, research laboratories, staff and student offices, and technical facilities.

Instrumental equipment at the observing stations located in the Catalina Mountains includes a 61-inch reflecting telescope used for a variety of investigations, including high-resolution photography of the moon and planets; a five-foot reflector, a 40-inch reflector, and a 28-inch reflector, all used principally for photoelectric photometry, including investigations in the infrared; an 18/27/48-inch Schmidt telescope for wide-field infrared photometry; and several smaller instruments. A 21-inch telescope for planetary photography is located on Tumamoc Hill. Staff members of the Lunar and Planetary Laboratory participate in supervision of doctoral dissertations.

The principal areas of research at the Steward Observatory include galactic and extragalactic investigations, both observational and theoretical; mm wave and sub-mm wave astronomy; infrared....
astrophysics; spectrographic and photometric research on single and multiple stars; astronomical instrumentation; theoretical investigations of stellar atmospheres and interiors, the interstellar medium, star formation, and magneto-hydrodynamics and general relativity applied to astrophysical problems.

502. Astronomical Instrumentation Project (3) II 1993-94 Design, construction, and testing of an astronomical instrument chosen by each student under the guidance and supervision of the instructor. Regular class sessions are devoted to discussing techniques and reporting progress and problems.

503.* Introduction to the Solar System (3) I 1993-94 (Identical with PTYS 503)

515. Interstellar Medium and Star Formation (3) II 1994-95 Derivation of physical conditions from spectral data. Ionized, atomic and molecular clouds, interstellar dust and magnetic fields. Ionization equilibrium, heating and cooling, shocks, dynamics, collapse and fragmentation, outflows and protostellar evolution.

518.* Modern Astronomical Instrumentation and Techniques (3) I 1993-94 Radiant energy; signals and noise; detectors and techniques for imaging, photometry, polarimetry and spectroscopy. Examples from stellar and planetary astronomy in the x-ray, optical, infrared and radio. (Identical with PTYS 518)

522. Atomic and Molecular Astrophysics (3) I 1994-95 Interpretation of astronomical spectra: basic aspects of atomic and molecular spectra and processes that enable one to infer physical conditions in astronomical environments from analysis of their electromagnetic spectra. Familiarity with basic quantum mechanics is assumed.

523. Statistical Mechanical Problems in the Space Sciences (3) I 1994-95 (Identical with PTYS 523)

535. Stellar Structure (3) II 1993-94 Equations of stellar structure, virial theory, energy transport, equations of state, opacities, nuclear reactions, stellar models, evolution of low and high mass stars, observational tests, rotation and magnetic fields, binary evolution.

540. Structure and Dynamics of Galaxies (3) I 1994-95 Observational properties of galaxies; structure, kinematics, star and gas content. Structure of our own galaxy. Dynamics of stellar systems: equilibrium, instabilities, internally and externally driven evolution.

541. Extragalactic Astronomy and Cosmology (3) II 1994-95 The structure, origin and evolution of the physical universe from theory and observations of systems outside our own galaxy. Relativistic cosmology; galaxy evolution and clustering; active galaxies and quasars; the microwave background, galaxy formation, the hot big bang and physics of the early universe. P. 540.

545. Stellar Atmospheres (3) I 1993-94 Radiative transfer, gray atmosphere, opacity, line formation, non-LTE, curves of growth, stellar hydrodynamics, planetary applications. (Identical with PTYS 545)

553. Solar System Dynamics (3) II 1993-94 (Identical with PTYS 553)


556a-556b. Electrodynamics of Conducting Fluids and Plasmas (3-3) 1994-95 (Identical with PTYS 556a and 556b)

575. General Relativity and Cosmology (3) II 1994-95 General relativity with application to celestial mechanics, stellar structure, gravitational radiation, black holes, gravitational lensing and cosmology. Cocke

582. High Energy Astrophysics (3) II 1993-94 Radiation mechanisms, synchrotron radiation, charged particle acceleration, pulsars, black holes, accretion disks, X-ray binaries, gamma-ray sources, radio galaxies, active galactic nuclei. (Identical with PHYS 582 and PTYS 582)

589. Topics in Theoretical Astrophysics (3) [Rpt.] I (Identical with PHYS 589)

May be convened with 400-level course.

Atmospheric Sciences

Physics-Astronomical Sciences

Building, Room 542
(602) 621-6831

Professors E. Philip Krider, Head, George A. Dawson (Emeritus), Robert E. Dickinson, Benjamin M. Herman, A. Richard Kassander (Emeritus), Richard M. Schotland, William D. Sellers, Dean O. Staley (Emeritus)

Associate Professor Kenneth C. Young Assistant Professors Eric A. Betterton, Steven L. Mullen, Joseph A. Zehnder

The Department of Atmospheric Sciences offers programs leading to the Master of Science and Doctor of Philosophy degrees. Research is conducted through the Institute of Atmospheric Physics in areas such as climate and global change, mesoscale meteorology, atmospheric dynamics, radiative transfer, remote sensing, atmospheric aerosols, atmospheric chemistry, cloud and precipitation physics, lightning and atmospheric electricity.

An undergraduate major or minor in atmospheric sciences or meteorology is not required for admission but some knowledge of the field is desirable. Applicants with undergraduate majors in physics, chemistry, mathematics or engineering are particularly encouraged to apply.

Degrees

Master of Science: 30 units of graduate work, including 541a-541b, 551a-551b, and at least two other graduate-level atmospheric sciences courses, are required. All candidates must submit a thesis or manuscript which has been judged by the student's committee to be acceptable for publication in an appropriate scientific journal and must pass a comprehensive written examination in the field.

Doctor of Philosophy: The Doctor of Philosophy with a major in atmospheric sciences is primarily a research degree. The candidate will be expected to demonstrate a proficiency in statistics and computer programming, complete at least 36 units of graduate course credit in the major field, 18 units of dissertation credit, and fulfill the minor requirement. All Ph.D. students must pass a written and oral preliminary examination and complete and defend a dissertation based on original research.

Students admitted into the Ph.D. program, who do not have an M.S. degree, are required to pass a qualifying examination, usually during their third semester. Students admitted with an M.S. degree may petition their committee to be exempted from this exam. The committee will make a decision on exemption based upon the candidate's performance in both course work and research.

All Ph.D. candidates in atmospheric sciences are required to complete a minor program. Requirements for the minor vary within the university and the student should consult the particular department in which they plan to minor for specific requirements.

Students entering the Ph.D. program in atmospheric sciences with an M.S. degree in another field are permitted to minor within the department with the approval of their committee. This minor will consist of 12 units of atmospheric sciences at the 500 level or higher in subjects other than those directly related to their area of research. These courses are in addition to those required for the Ph.D. program. With the approval of their committee, candidates can take up to six units of minor courses in other departments that relate to their area of research.

Doctoral students from other department who wish to minor in atmospheric sciences must complete 12 units of atmospheric sciences at the 500 level or higher, including ATMO 541a and 551a.

521.* Physical Climatology (3) II Heat and water balances of the earth-atmosphere system viewed from both the local and global scales; paleoclimatology and theories of climatic change; man's impact on climate. P. 171. (Identical with AR L 521)

530. Micrometeorology (3) I 1993-94 Theoretical aspects of atmospheric turbulence, includ-
541a-541b.* Dynamic Meteorology (3-3)
Thermodynamics and its application to planetary atmospheres, hydrosystems, fundamental concepts and laws of dynamic meteorology. P, PHYS 121; MATH 254. (Identical with PTYS 541a-541b)

544. Physics of High Atmospheres (3) II 1993-94 (Identical with PTYS 544)


551a-551b.* Introduction to Physical Meteorology (3-3)
Introduction to atmospheric physics that includes the composition and chemistry of the atmosphere, kinetic theory, the mechanics of ideal and real fluids, aerosol mechanics, atmospheric acoustics, atmospheric radiation, scattering, radiative transfer, atmospheric optics, cloud physics, and atmospheric electricity. P, PHYS 121; MATH 254.

560. Aerosol Science and Engineering (3) I 1993-94 (Identical with CH E 560)

562.* Computer Methods in the Atmospheric Sciences (3) I Introduction to computer methods for solving physical and statistical problems in the atmospheric sciences. P, ENGR 101 (FORTRAN) or equivalents.


565.* Mesoscale Analysis (3) II Description, analysis, and dynamics of weather systems of the mesoscale. Topics include fronts, thunderstorms, gravity waves, lake effect storms and sea breezes. P, 541b, 571.

567. Inverse Problems in Geophysics (3) I (Identical with GEOS 567)


583. Remote Sensing Instrumentation and Techniques (3) II (Identical with ECE 583)

585. Tropospheric Chemistry (3) I 1993-94 Tropospheric chemistry of both the natural and polluted atmosphere. Topics include biogeochemical cycling of major constituents, urban air pollution and measurement techniques. P, 300a.

590. Atmospheric Electricity (3) II 1993-94 An introduction to the sources and chemistry of atmospheric ions, fair weather electricity, the global circuit, electrical structure of clouds, thunderstorm electrification, lightning, lightning electromagnetic fields, and lightning protection. P, MATH 322, PHYS 116. (Identical with ECE 589)

590.* Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

595. Colloquium
a. Atmospheric Measurement Techniques (1-3) II 1993-94
b. Global Climate Change (2) I P, strong quantitative background in HWR, ATMOS, GEOS or RNR. (Identical with GEOS 595b and HWR 595b)
c. General Circulation Observations and Modeling (3) II P, 541a, 551a, ENGR 101 (FORTRAN). (Identical with GEOS 595c and HWR 595c)

*May be converted with 400-level course.

641. Theoretical Meteorology (3) I Methods of solution of the hydrodynamic equations; identification and analysis of acoustic, gravity, Kelvin-Helmholtz, inertial, Kelvin, barotropic and baroclinic waves. P, 541b.


656a-656b. Atmospheric Radiation and Remote Sensing (3-3) 1994-95 Theory of atmospheric radiative transfer processes; specific methods for solving the relevant equations; applications to problems in radiative transfer; theoretical basis for remote sensing from the ground and from space; solutions to the "inverse" problem. P, MATH 254. (Identical with OPTI 656a-656b)

Biochemistry (BIOC)

Biological Sciences West Building
Room 357
(602) 621-5770

Professors Michael A. Wells, Head, Hans J. Bohnert (Molecular and Cellular Biology), Don P. Bourque (Molecular and Cellular Biology), Michael F. Brown (Chemistry), Herbert E. Carter (Emeritus), Michael A. Cusanovich, Leslie S. Forster (Emeritus), Eugene W. Gerner (Radiation Oncology), Darrel E. Goll (Animal Sciences), William J. Grimes, Richard B. Hallack, David J. Hartshorne (Animal Sciences), Mark R. Haussler, John G. Hildebrand (Molecular and Cellular Biology; Division of Neurobiology/ARL), Victor J. Hruby (Chemistry), Richard G. Jensen, and Henry H. Koffler (Microbiology and Immunology; Molecular and Cellular Biology), John H. Law, John W. Little, David W. Mount (Molecular and Cellular Biology), David F. O'Brien (Chemistry), John A. Rupley, Eugene G. Sander, Marc E. Tischler, Gordon Tonn, Henry I. Yamamura (Pharmacology; ARL)

Associate Professors Danny L. Brower (Molecular and Cellular Biology), Louise M. Canfield, Carol L. Dieckmann, Robert J. Gillies, Jennifer D. Hall (Molecular and Cellular Biology), Martinez J. Hewlett (Molecular and Cellular Biology), Neil E. MacKenzie (Pharmaceutical Sciences), Elizabeth Vierling

Assistant Professors Mark S. Dodson, Roger L. Miesfeld, William R. Montfort

Teaching and research in biochemistry are carried out in several locations in the University and involve the efforts of the above-listed faculty members. These individual faculty members constitute the University Department of Biochemistry, which is responsible for instruction in biochemistry in the Colleges of Agriculture, Arts and Sciences, and Medicine.

The Department of Biochemistry offers the Master of Science and Doctor of Philosophy degrees. Except in unusual circumstances, however, the department will not admit graduate students whose stated objective is the Doctor of Philosophy degree. The department also offers undergraduate instruction in programs of the Colleges of Agriculture, Arts and Sciences, and Medicine, and undergraduate Bachelor of Science and Bachelor of Arts degrees in biochemistry.

Research areas in which graduate studies may be pursued cover most modern aspects of biochemistry including electron and X-ray crystallography; electron tomography; protein structure and function; bioenergetics; plant molecular biology and biochemistry; gene regulation and expression; genetic engineering; membrane and cell surface biochemistry; muscle biochemistry and cell motility; hormone biochemistry, insect
biochemistry; and protein, lipid and nucleic acid metabolism.


505. Eukaryotic DNA Replication (3) [Rpt./1] I 1994-95 (Identical with CBIO 505)

510. Plant Molecular Biology (3) II 1994-95 (Identical with PL S 510)

511.* Molecular Biology (3) II (Identical with MCB 511)

516.* Computer Analysis of Sequences (3) II (Identical with MCB 516)

520.* Pathways and Signals in Cells (3) II Objectives are to outline various mechanisms of intracellular signaling. This includes the chemical and structural bases for the action of second messengers, e.g., cyclic nucleotides, cAMP, calcium, and cyclic guanosine monophosphate. P, BIOC 460, 462a or equivalent; open to undergraduates with permission. (Identical with MCB 520, AN S 520)

543. Research Animal Methods (3) I (Identical with V SC 543)

545. Concepts in Genetic Analysis (3) I (Identical with MCB 545)

555. Molecular Mechanisms of Development (3) II (Identical with MCB 555)

560.* General Biochemistry (5) I II Fundamentals of biochemistry, including proteins, nucleic acids, enzymes, carbohydrates and lipids and their metabolic relationships. Open to nonmajors only. P, 181, CHEM 241b. (Identical with CHEM 560 and TOX 560)

561a-561b. Introduction to Biochemical Literature (1-1) II Discussion of the biochemical literature aimed at helping the student evaluate and report the published literature. Primarily for first year graduate students planning a career in biochemistry and desiring to prepare themselves for continued study. P, CR, 462a-462b. 561a is not prerequisite to 561b. (Identical with CHEM 561a-561b)

562a-562b.* Biochemistry (3-3) Introduction to the properties and metabolism of proteins, nucleic acids, enzymes, carbohydrates and lipids. Designed primarily for majors and minors in chemistry, biochemistry and biology. P, CHEM 241b, CR, CHEM 322, 325. (Identical with CHEM 562a-562b and TOX 562a-562b)

563.* Biochemistry Laboratory (2) II Introduction to experimentation with biochemical systems, processes and compounds of biochemical importance. 1R, 5L. P, 460/560 or 462a/562a, and CR, 462b/562b.

565. Enzymes (3) I Advanced consideration of enzyme structure and function. P, 462a/562a, CHEM 480b. (Identical with CHEM 565)

568. Nucleic Acids (4) I Chemistry, structure, and function of nucleic acids; replication, transcription, translation, gene organization, regulation of gene expression and organelle nucleic acids. Both prokaryotic and eukaryotic systems will be considered. P, BIOC 411/511, MCB 411/511, or an equivalent introductory molecular biology course, or permission of the instructor. (Identical with GENE 568, MCB 568 and NFS 568)

569. Topics in Gene Regulation (2) II 1994-95 Behavior of gene regulatory systems in prokaryotes and eukaryotes. Knowledge of mechanisms is assumed and discussed when needed, but emphasis is on regulatory circuitry. Most lectures will be student presentations. (Identical with MCB 569) P, 568 or permission of instructor.

572. Biological Regulation (4) I Advanced treatment of the biomedical aspects of biological regulation in eukaryotic cells. Topics to be discussed include regulation of cellular metabolism, growth and cell division in both plant and animal cells. P, 462a-462b or consult department before enrolling. (Identical with MCB 572)

574. Advances in Mammalian Genetics (2) [Rpt./1] I 1994-95 Student participation in the presentation and discussion of current literature covering recent advances in the molecular analysis of mammalian genetic loci. P, under graduate courses in genetics and molecular biology. (Identical with GENE 574 and MCB 574)

577. Biomolecular Structure II (3) II 1994-95 Advanced study of macromolecular structure; theory, methods, and results of x-ray crystallography and NMR. P, 585, or permission of instructor.

585. Biological Structure (4) I Introduction to the current understanding and methods used for study of the structure, thermodynamics, and dynamics of proteins, nucleic acids, and membranes. P, CR, 462a-462b, CHEM 480a-480b. (Identical with CHEM 585)

586. Intracellular Messengers (2) I 1993-94 (Identical with NRSC 586)

588. Principles of Cellular and Molecular Neurobiology (4) I (Identical with NRSC 588)

597. Workshop
   a. Recombinant DNA Techniques (2) S Open to high school biology teachers only. R/L. (Identical with MCB 597a)
   *May be convened with 400-level course.

612. Biological Electron Microscopy (4) I (Identical with MCB 612)

621. Molecular, Plant, Microbe Interaction (3) II 1994-95 (Identical with PL P 621)

665. Analysis & Purification of Proteins (3) II 1991-92 (Identical with AN S 665)

681. Introduction to Biochemical Research (1-5) I II Supervised research experiences in the labs of individual faculty members. 3 or 6L. Open only to first-year majors. P, CR, 561a-561b.

696. Seminar
   a. Biochemistry I (1-3) [Rpt./9 units]
   b. Biochemistry II (1-3) II [Rpt./9 units]

800. Research (1-16) Yr.

801. Medical Biochemistry (6) II Comprehensive treatment of general biochemistry with clinical applications, oriented toward human biology. Includes protein and nucleotide chemistry and metabolism, enzymology, lipid and carbohydrate metabolism, metabolic regulations, biochemical nutrition, biochemical endocrinology and related topics. Includes clinical case studies, clinical discussions, tutorials and computer-assisted instruction.

891. Preceptorship
   a. Biochemistry (3-12) [Rpt./12 units]
Biophysics (BIP)
Graduate Interdisciplinary Program in Biophysics

At the time of publication of this catalog, the Graduate Interdisciplinary Program in Biophysics was undergoing programmatic changes. For current information, contact R. Gruener, 621-8368.

578a-578b. Introduction to Biophysics (3-3)
Introduction to the structure of cells and the chemistry of macromolecules, followed by a survey of the principal areas of biophysics: molecular biophysics, membrane and cellular biophysics, and systems biophysics. P, PHYS 415b, CHEM 480a-480b.

681. Introduction to Biophysical Research (1-2) [Rpt./3 units] I II S Supervised research experiences in the labs of individual faculty members 3-6L. Open only to first-year majors.

696. Seminar
a. Biophysics I (1-2) [Rpt./3 units] I Open to majors only.

Business Administration
McClelland Hall
Accounting (602) 621-2620
Finance (602) 621-7554
Management Information Systems (602) 621-2387
Management and Policy (602) 621-1035

Marketing (602) 621-3519
Karl Eller Graduate School of Management (602) 621-2169

Committee on Business Administration

Professors William B. Barrett (Vice Dean), Chair, Andrew D. Bailey, Jr. (Accounting), Lee Roy Beach (Management and Policy), Edward A. Dyl (Finance and Real Estate), Elizabeth Hoffman (Associate Dean, Karl Eller Graduate School of Management)

Associate Professors Christopher P. Puto (Marketing), Sudha Ram (Management Information Systems), Stanley S. Reynolds (Economics)

The committee offers programs leading to the Master of Business Administration degree with a major in business administration and specialized concentrations in functional areas, specialized masters' degrees in functional areas and a Doctor of Philosophy degree with a major in management and specialized concentrations in functional areas.

These degree programs are designed to educate students to modern scientific research methods as applied to general and specialized management problems and to prepare students for careers in education, management, and government.

All prospective students should check with the academic department of their specialization with respect to matters of program focus and requirements.

Degrees
Master of Business Administration and specialized masters' degrees in functional areas: For information concerning this degree see Requirements for Masters' Degrees/Master of Business Administration elsewhere in this catalog.

Doctor of Philosophy: The degree program is interdisciplinary and draws heavily on the fields of mathematics, statistics, economics, and the behavioral sciences, as well as knowledge of specific functional areas of management.

Candidates must have a bachelor's degree and proficiency in mathematics at the level of MATH 125a-125b. Individual functional areas will vary to allow for differing backgrounds and to accommodate different special interests. The program requires a concentration in one of the functional areas available in the college: accounting, finance, management information systems, management and policy, and marketing. Minor fields are selected to complement the major area of emphasis. Courses are chosen with the approval of the major and minor advisors to provide a strong theoretical and methodological background for research in the candidate's chosen discipline.

Cancer Biology (CBIO)
Arizona Health Sciences Center
Room 0914
(602) 626-7479

Graduate Interdisciplinary Program in Cancer Biology

Committee:

Professors G. Tim Bowden, Chair (Radiation Oncology), David S. Alberts (Internal Medicine), Harris Bernstein (Microbiology and Immunology), Eugene W. Gerner (Radiation Oncology), William J. Grimes (Biochemistry), Evan M. Hersh (Internal Medicine), Junetsu Ito (Microbiology and Immunology), John W. Little (Biochemistry), Neil H. Mendelson (Molecular and Cellular Biology), David W. Mount (Molecular and Cellular Biology), Raymond B. Nagle (Pathology), Garth Powis (Pharmacology), Sydney E. Salmon (Internal Medicine), Nobuyoshi Shimizu (Molecular and Cellular Biology), I. Glenn Sipes (Pharmacology and Toxicology), Raymond Taetle (Internal Medicine), Samuel Ward (Molecular and Cellular Biology), Ronald S. Weinstein (Pathology)

Associate Professors Dan L. Brower (Molecular and Cellular Biology), Louise M. Canfield (Biochemistry), Anne E. Cress (Radiation Oncology), William S. Dalton (Internal Medicine), Carol Dieckmann (Biochemistry), Harinder S. Garewal (Hematology-Oncology), Helen Gensler (Radiation Oncology), Robert Gillies (Biochemistry), Jennifer D. Hall (Molecular and Cellular Biology), Mary J. C. Hendrix (Anatomy), Siraj Multi, Research Associate Scientist (Pharmacology and Toxicology)

Assistant Professors Alison E. Adams (Molecular and Cellular Biology), Kit S. Lam (Internal Medicine), Daniel C. Liebler (Pharmacology and Toxicology), Alan F. List (Medicine), Jesse Martinez (Radiation Oncology), Roger L. Miesfeld (Biochemistry), Marianne Powell (Internal Medicine), Charles W. Taylor (Internal Medicine), Ted Weinert (Molecular and Cellular Biology)

Scientists from various departments comprise the interdisciplinary program in Cancer Biology which offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in cancer biology. The curriculum of the cancer biology graduate program is designed to introduce students to the body of knowledge that has been derived from experiments on the production, properties, and therapy of cancer.
and to assure that the students have the necessary background in one or more areas of related fundamental science to enable them to do original research.

For admission to the program students should have a B.S. or B.A. degree or an M.S. degree usually with a major in biochemistry or chemistry, molecular biology, genetics, cell biology, toxicology or a closely related area and with a cumulative grade-point average of at least 3.00 (B). The background of the students should include basic courses in these areas as well as several advanced courses from Chemistry, Microbiology and Immunology, Molecular and Cellular Biology, Biochemistry, Genetics, Pharmacology and Toxicology. Prior research experience is highly desirable and may be recognized in certain instances as evidence of competence in that area. All applicants must take the Graduate Record Examination, including the advanced test in chemistry or biology.

The deadline for receipt of application forms for fall admission is April 1 and for spring admission, November 1.

All students are required to complete 13 units of core courses specified by the program and which include: 3 units of Cancer Biology (555), 3 units of Environmental Carcinogenesis (551), 2 units of Cancer Cell Biology (595d), 3 units of Cancer Genetics and Cytogenetics (589), and 2 units of Cancer Biology Seminar (596h).

505. Eukaryotic DNA Replication (3) [Rpt./1] I 1994-95 Molecular and biochemical aspects of DNA replication in mammalian cells will be described in conjunction with discussions of recent journal articles on selected topics. Includes the regulation of S phase within the eukaryotic cell cycle; nuclear organization during DNA synthesis; DNA replication enzymes; the viral, yeast and embryo models of DNA replication; the initiation of DNA replication; DNA replication origins and the reconstitution of DNA replication complexes. P. BIOC 462h. (Identical with BIOC 505, MCB 505, and MBIM 505) Cress

551. Molecular Mechanisms of Carcinogenesis (3) II 1993-94 Physical and chemical carcinogenesis. Special emphasis will be upon molecular aspects of the interaction of the carcinogenic agents with mammalian cells and the subsequent mutagenic and metabolic consequences of such interactions. The topics of oncogene activation and tumor suppressor gene inactivation induced by carcinogens during multi-stage carcinogenesis will be emphasized. The molecular biology techniques used in the study of carcinogenesis will also be covered. P; consult program before enrolling. (Identical with MBIM 551 and RONC 551). Bouder.

555. Cancer Biology (3) II 1994-95 Fundamental biological aspects of neoplastic growth at the organ, cellular, and molecular levels; emphasis on the etiology, behavior, and therapy of neoplasms. (Identical with ANAT 555, IMED 553, MBIM 555 and RONC 555).


595. Colloquium d. Special Topics in Cell Biology (2) [Rpt./6 units] II 1993-94 (Identical with ANAT 595d, MCB 595d, MBIM 595d, and RONC 595d) Gerner

596. Seminar h. Cancer Biology Series (1) I (Identical with RONC 596h)

681. Introduction to Cancer Biology Research (2) I II 1994-95 Supervised research experience in the laboratories of individual faculty members.

685. Molecular Mechanisms of Carcinogenesis (3) I 1994-95 For a description of course topics, see 551. (Identical with MBIM 851 and RONC 851).


896. Seminar h. Cancer Biology Series (1) I (Identical with RONC 896h)

*Available on both 500 and 800 levels.

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**Chemical Engineering (CHE)**

Geology Building, Room 120
(602) 621-2591

Professors Thomas W. Peterson, Head, Milen Bier, Joseph F. Gross (Emeritus), Richard M. Edwards (Emeritus), Alan D. Randolph, Thomas R. Rehm, Farhang Shadman, Raymond Sierka (Civil Engineering), Jost O. L. Wendt, Donald H. White (Emeritus) Associate Professors Robert Arnold (Civil Engineering), Curtis W. Bryant (Civil Engineering), William P. Cosart, Bruce Logan (Civil Engineering) Assistant Professors Roberto Z. Guzman-Zamudio, James Baygents, Kimberly L. Ogden

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in chemical engineering. The graduate program is designed to provide advanced work in a core of transport phenomena, thermodynamics and reaction engineering with additional selected work in mass transfer, heat transfer, fluid dynamics, control theory, and process simulation. The following interdisciplinary options are also available: biomedical engineering, bioprocess engineering, energy systems engineering, and materials engineering. For details concerning these options see Engineering elsewhere in this catalog.

**Degrees**

Master of Science: Each student program must include 505, 506, and 530, and at least nine additional units of course work in chemical engineering or allied fields. A research project on an appropriate chemical engineering topic and proficiency in computer techniques are required. Ordinarily a thesis is required but, under extraordinary circumstances and with advance approval, a nonthesis program consisting of 33 units of approved course work plus two units of 696a is possible.

Doctor of Philosophy: In addition to the requirements for the Master of Science degree, advanced work in mathematics, chemistry, physics, or other engineering fields is required. No foreign language is required. Teaching experience is a required part of each student's progress toward a Doctor of Philosophy degree with a major in chemical engineering. A minimum of one semester of teaching activity will be assigned each student during his/her studies.


505. Advanced Chemical Engineering Transport Phenomena (3) I Momentum, energy and mass transport in continua, solution of multidimensional laminar flow problems, turbulence, boundary layer theory. P. 305.

506. Advanced Chemical Engineering Thermodynamics (3) I Advanced applications of First and Second Laws, nonideal gases and liquids and their mixtures, principles of chemical equilibrium, and molecular theory. P. 326.


520. Chemical Reaction Engineering (3) I Application of thermodynamic and kinetic fundamentals to the analysis and design of chemical reactors. P. 201, 326.

521. Topics in Real-Time Computing (3) I Introduction to microcomputer- and minicomputer-based real-time computing for data acquisition and process control. Includes study of various languages and operating systems. 2R, 3L.


532. Solid-Fluid Reactions (3) I Characterization of solid structural properties; principles of heterogeneous reactions involving a fluid
and a reacting solid. P. 326 and 420, or MSE 450R and 412. (Identical with MSE 532)

535.* Corrosion and Degradation (3) II (Identical with MSE 535)

541. Industrial Energy and Power Management (3) II (Identical with NEE 541)

548. Combustion Generated Air Pollution (3) II (Identical with A ME 548)

551.* Chemical and Physical Fundamentals of Air Pollution (3) II Study of the kinetics, transport phenomena and phase equilibria of urban air pollution problems. P. 305, 420.

553.* Space Manufacturing (3) I Basics of producing high value added materials in microgravity, as well as commodities for use in space from extraterrestrial resources.

554.* Law for Engineers/Scientists (3) II Topics covered in this course include patents, trade secrets, trademarks, copyrights, product liability contracts, business entities, employment relations and other legal matters important to engineers and scientists. (Identical with ENGR 554)

560.* Aerosol Science and Engineering (3) I 1993-94 Physics, chemistry, mechanics, and optics of atmospheric aerosol particles. Topics include formation, dynamics, nucleation and growth, coagulation, scattering and absorption of radiation, deposition and aerosol technology. (Identical with ATM 560 and ECE 560)

561.* Chemical Process Simulation (2) II Use of existing large, modular computer programs for computer-aided process design and analysis; program structure, convergence accelerators and control blocks. P. 442.

570.* Fundamentals of Polymeric Materials (3) II Fundamental chemical, physical, and mechanical properties of organic plastics, fibers, coatings, adhesives, and elastomeric polymers.

580.* Bioseparation Techniques for Engineers (3) II Methods of separation for purification of bioprocess products—amino acids, proteins, nucleic acids, carbohydrates, lipids, cells.

581.* Bioreactor Engineering (3) I Introduction to biotechnology; chemistry of microorganisms; design of bioreactors to include cellular and enzyme reactors of all types; transport phenomena and control of bioreactors; instrumentation and measurement in bioreactors.

583. Remote Sensing Instrumentation and Techniques (3) II (Identical with ECE 583)

585.* Biomedical Transport Phenomena (3) I 1994-95 Transport processes in the cardio-vascular system, hemorhology, pharmacokinetics, enzyme kinetics, extracorporeal mass transport devices, biocompatible materials. P. 305 or A ME 331a, and MATH 223.

586. Advanced Biomedical Engineering (3) II 1993-94 Analytical methods applied to problems in biochemical and biomedical engineering. Course includes invited lecturers, journal critiques, and preparation of an original paper. P. MATH 223.

*May be covened with 400-level course.


645. Advanced Solar Engineering (3) II (Identical with NEE 645)


696. Seminar

a. Chemical Engineering (1) [Rpt./6] I II
b. Combustion (1) [Rpt./6] I II
c. Kinetics (1) [Rpt./6] I II
d. Pollution Control (1) [Rpt./6] I II
e. Crystallization (1 to 3) [Rpt./6] I II
f. Fluid Mechanics (1) [Rpt./6] I II
g. Biomedical (1) [Rpt./6] I II
h. New Developments (1) [Rpt./6] I II

Chemistry (CHEM)

Old Chemistry Building, Room 221
(602) 621-6354


Associate Professors Michael F. Burke, Eugene A. Mash, Jr., John V. Rund, Mark A. Smith, G. Krishna Vemulpalli, David E. Wigley

Assistant Professors Ludwik Adamowicz, Steven W. Buckner, Daniel P. Dolata, Jaquelyn Gervay, Robin L. Holt, S. Scott Saavedra

The department offers programs leading to the Master of Arts, Master of Science, Master of Education, and Doctor of Philosophy degrees with a major in chemistry. Specializations are available to help students plan an appropriate graduate program.

and can include chemical physics, materials science, optical sciences, and several other interdisciplinary fields.

Prospective students should write to the Office of Academic Affairs in the Department of Chemistry for information and brochures about the variety of research programs, the faculty involved, the facilities available, and the guidelines for the graduate program in chemistry. Teaching assistantships and/or fellowship support are available for all first-year graduate students. Research support is also available for qualified graduate students.

New students are assisted and advised by the departmental Graduate Program Committee until they are prepared to select a research program and a research adviser. The committee administers examinations for all new students during the week before registration each semester. These examinations cover various branches of chemistry, and the results are used to help students plan an appropriate graduate program.

Degrees

Master of Arts: Students who plan to teach chemistry in secondary schools will find this program adapted to their needs. A thesis is required but, at the discretion of the department, it need not embody the results of original laboratory research. All students must pass a final oral examination.

Master of Science: A thesis based upon original research is required. All students must pass a final oral examination.

Master of Education: See Master of Education elsewhere in this catalog.

Doctor of Philosophy: The Doctor of Philosophy with a major in chemistry is primarily a research degree. The number and selection of courses is tailored to the individual student's needs and interests according to the guidelines available from the Office of Academic Affairs in the Department of Chemistry. The minor work may be satisfied within the Department of Chemistry. Since teaching experience strengthens an individual's grasp of principles, a year of teaching is generally required of each student. A dissertation based upon original laboratory research is required. All students must pass a preliminary examination and a final oral examination.


503. Intermediate Physical Chemistry (3) I General survey of physical chemistry, includ-
Detailed analysis of the factors which influenced to synthetic problems in organic chemistry and the methods by which they are applied. P. 480b.

504. Intermediate Inorganic Chemistry (3) I Principles of modern inorganic chemistry, including synthesis, structure, physical properties, and reactivity of inorganic compounds and materials.

507. Radiochemistry and Radiation Detection (3) I (Identical with NEE 507)

510a-510b. Advanced Inorganic Chemistry (3-3) II I Survey at the advanced level of the chemistry of the elements. P. 410.

512. Advanced Inorganic Preparations (2 to 4) II Modern inorganic syntheses, including instruction in the use of high pressure, temperature, and vacuum techniques and in the manipulation of unstable compounds. 6 to 12L.

517. Structural Chemistry (3) II Introduction to the determination of structures of complex molecules by X-ray crystallography; the evaluation of structural information; current topics in structural chemistry. 2R, 3L.


521. Advanced Instrumental Analysis (3) I Topics in spectrophotometry, emission spectrometry, chromatography, electroanalysis, principles of instrumentation and data acquisition at an advanced level. P. 424, 480b.

522. Electroanalytical Methods (3) II Principles of electrochemistry and electroanalysis, including topics on electrochemical equilibrium and kinetics, potentiometry, voltammetry, amperometry, coulometry, chronopotentiometry, and modern cyclic and pulse methods. P. 480b.

523. Application of Equilibrium Principles in Analysis (3) II Mathematical description of equilibria in aqueous and nonaqueous systems; theoretical basis of analytical determinations. P. 480b.

524. Chemical Instrumentation (4) II Data acquisition and experiment control by analog and digital techniques; design of chemical instrumentation. 3R, 3L, P. 424.

525. Chemistry of Metal Chelates (3) I Theory underlying the application of chelating agents in chemical analysis. P. 523.


527. Analytical Separations (3) I Fundamentals of separation processes—single and multistage; differential migration methods.

528. Advanced Instrumental Laboratory (2) I Laboratory experiments in spectrophotometry, emission spectrometry, chromatography and electroanalysis. 6L. P, CR, 521.

540. Organic Syntheses (3) I Organic reactions and the methods by which they are applied to synthetic problems in organic chemistry. P. 241b, 480b.


560. General Biochemistry (5) I I (Identical with BIOC 560)

561a-561b. Introduction to Biochemical Literature (1-1) (Identical with BIOC 561a-561b)

562a-562b. Biochemistry (4-3) (Identical with BIOC 562a-562b)

563. Enzymes (3) I (Identical with BIOC 563)

580. Introduction to Quantum Chemistry (3) I An introduction to quantum mechanics, with applications to atomic structure and spectra, the nature of chemical bonding and molecular structure. P. 480b.

581. Chemical Thermodynamics (3) II Advanced concepts in both classical and modern thermodynamics, with particular emphasis on thermodynamics in solution. P. 480b.

582. Statistical Thermodynamics (3) I Introduction to classical and quantum statistical thermodynamics with application to ideal gases and simple solids; equations of state and elementary solution theory. P. 480b.

583. Chemical Kinetics (3) II Classical and modern techniques in studies of chemical reactions. P. 480b.

584. Practical NMR Spectroscopy (3) I The basic principles of nuclear magnetic resonance (NMR) spectroscopy; the operation of Fourier transform NMR spectrometers and interpretation of NMR spectra. P. 480b.

585. Biological Structure (4) II (Identical with BIOC 585)

586. Introduction to Molecular Spectroscopy (3) II Modern molecular spectroscopy including rotational, vibrational, and electronic spectroscopy and their various combinations. P, 480a-480b or consult department before enrolling.

591. Preceptship a. * College Teaching (1) [Rpt./2 units] I II S
b. * Chemistry Course Development (1) [Rpt./2 units] I II S
c. * Professional Service (1) [Rpt./2 units] I II S

Note: A combination of 591a, 591b, or 591c may be taken up to a total of 6 units.

*May be converted with 400-level course.

613. Kinetics and Mechanisms of Inorganic Reactions (3) I An examination of the techniques and reasoning used in assigning reaction mechanisms. P. 510b.

640. Organometallic Compounds (3) I Compounds containing carbon-to-metal bonds, with emphasis on those of the transition elements, and the determination of their structures. P. 410.

651. Coordination Chemistry (3) I Selected topics in the area of coordination compounds of transition metals, with particular emphasis on ligand field theory, the symmetry aspects of the spectral properties of transition metal complexes and their magnetic behavior. P. 510b or CR.

658. Computation in Chemistry (3) [Rpt./1] State-of-the-art computational methods in chemical research, including approximate and ab initio electronic structure methods, molecular mechanics, and modeling graphics. 2R, 3L. P, consult department before enrolling.


642a-642b. Polymer Chemistry (3-3) I II Synthesis, stereochemistry, and mechanisms of formation of high polymers. 642a: Condensation and ring-opening polymers. 642b: Vinyl polymers. P. 540. 642a is not prerequisite to 642b.

644. Heterocyclic Compounds (3) I The behavior of the more important heterocyclic systems. P. 540.

645. Chemistry of Natural Products (3) I Isolation, structural elucidation, total synthesis, biogenesis, metabolism, and physiological importance of natural products. P. 540.

646. Advanced Organic Chemistry (3) [Rpt.] II Advanced topics in organic chemistry, such as peptide chemistry, computer simulations, bio-organic chemistry, and other topics characterized by faculty expertise. Topics will vary each semester. P, consult department before enrolling.

680. Quantum Chemistry (3) II Principles of quantum mechanics with applications to the properties of molecules. P. 580.

682. Statistical Mechanics (3) II Fundamental principles of classical and quantum statistical mechanics, the Darwin-Fowler method, Mayer cluster theory of gases, theory of fluids and related topics. P. 582.


687. Molecular Spectroscopy (3) I Applications of quantum mechanics to the interpretation of the spectra of molecules of chemical and biological interest. P. 580.

695. Colloquium a. Chemical Research Opportunities (1) I
b. Exchange of Chemical Information (1 to 3) [Rpt./7 units] I II S

696. Seminar a. Analytical Chemistry (1 to 3) [Rpt./8 units] I II
b. Inorganic Chemistry (1 to 3) [Rpt./8 units] I II
c. Organic Chemistry (1 to 3) [Rpt./8 units] I II
d. Physical Chemistry and Chemical Physics (1 to 3) [Rpt./8 units] I II

697. Workshop a. Chemical Instruments (1 to 3) [Rpt./8 units] I II

Chinese
(See East Asian Studies)
Civil Engineering and Engineering Mechanics (CE/EM)

Civil Engineering Building, Room 206
(602) 621-2266

Professors: Dinshaw N. Contractor, Acting Head, Donald A. DaDeppo, Chandrakant S. Desai, Martha W. Gilliland, Achintya Haldar, David J. Hall (Emeritus), Simon Ince (Hydrology and Water Resources), Rudolf A. Jimenez, James D. Kriegl (Emeritus), Emmett M. Laursen (Emeritus), Allan J. Malvick, Haaren A. Mikolofsky (Emeritus), Richmond C. Neff (Emeritus), Philip B. Newlin (Emeritus), Ralph M. Richard (Emeritus), Raymond A. Sierka, Ernest T. Smerdon

Associate Professors: Robert G. Arnold, Donald J. Baumgartner, Curtis W. Bryant, Muniram Budhu, Mohammad R. Ehsani, Donald B. Hawes (Emeritus), Panos D. Kiousis, Tribikram Kundu, Bruce E. Logan, Margaret S. Petersen (Emerita), Robert H. Wortman

Assistant Professors: Sonia H. Armaleh, George N. Frantziskonis, William M. Isenhower, Kevin E. Lansey, Hamid Sadatmanesh

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in civil engineering and engineering mechanics. Work is directed toward research and professional development in such areas as engineering mechanics, engineering materials, regional development and urban planning, highway engineering, hydraulics and fluid mechanics, environmental engineering, geomechanics, geotechnical engineering, water resources, structural engineering, and transportation. Certain interdisciplinary options are available by combining various areas of the program. For further information concerning these options see Engineering elsewhere in this catalog.

Degrees

Master of Science: A thesis or engineering report is required. At the option of the department, the degree may be awarded, without a thesis or engineering report, to candidates for the Doctor of Philosophy degree who have passed the preliminary examination.

Doctor of Philosophy: A minor field may be selected from architecture, chemistry, geology, mathematics, mechanical engineering, materials science and engineering, mining engineering, nuclear engineering, physics, or systems engineering, or from within the Department of Civil Engineering and Engineering Mechanics. Still other fields are available as minors with the approval of the head of the department.

Civil Engineering (CE)


503. Subsurface Fluid Dynamics (3) I (Identical with HWR 503)

504. Numerical Methods in Subsurface Hydrology (4) II (Identical with HWR 504)

511. Computer-Aided Geometric Design (3) (Identical with A ME 511)


522. Hydrology (3) I Discussion and analysis of major topics of the hydrologic cycle and their interrelationship, such as rainfall, infiltration, evaporation, and runoff. Statistical and probabilistic methods in water supply and flood hydrology. P, 321. (Identical with HWR 523 and AR L 523)

524. * Hydraulic Engineering Design (3) II Application of principles of hydraulic analysis to the design of hydraulic systems. Applications will vary and include hydropower systems, stilling basins, open channel distribution and collection systems, pipe networks and pumping systems, drainage problems and other topics. P, 522.


526. Water Quality Management (3) II (Identical with HWR 526)

527. * Computer Applications in Hydraulics (3) I Computer modeling of surface water hydraulics, flood plain hydraulics and water distribution systems. Theoretical basis. Application and design studies. (Identical with HWR 527)

528. * Introduction to Coastal Engineering (3) II Hydrodynamics of the coastal zone; coastal sediment processes and their interaction with structures; diffusion in coastal waters and marine outfall design; coastal zone management. P, 528.


532. * Advanced Structural Design in Steel (3) I Advanced problems in the analysis and design of steel structures including beam columns, plate girders, composite construction, multi-story buildings; static and dynamic lateral and vertical loads; connections; computer applications. P, 336.

533. Plastic Analysis and Design (3) I 1994-95 Material and member behavior to full plasticization; redistribution of forces; plastic design of continuous beams and frames; influence of axial and shear forces; deflections and rotations; alternating plasticity; shakedown analysis. P, 432 or consult department before enrolling.


536. Prestressed Concrete Structures (3) I 1994-95 Behavior, analysis, and design of statically determinate and indeterminate prestressed concrete structures. P, 337.

537. Advanced Structural Design in Concrete (3) II 1994-95 Advanced problems in the analysis and design of concrete structures, design of slender columns and one- and two-way slabs; lateral and vertical load analysis of bridges and multistory buildings; introduction to design for torsion and seismic forces; use of structural computer programs. P, 337.

540. * Foundation Engineering (3) II Settlement and bearing capacity of shallow and deep foundations; beam on elastic foundation; design of footings and pile foundations; foundations on metastable soils; the use of computer codes for foundation problems. P, 340.

541. Earth Structures in Geotechnical Engineering (3) I Stability analysis for earth slopes, including planar, circular piecewise-linear, and composite-surface methods: analyses for static and steady-flow conditions; earth pressure theories and calculations for simplified conditions; design of rigid and flexible retaining structures; design of braced and tie-back shoring systems; design of reinforced earth walls; computer-aided analysis and design. P, 340.


analytical and approximate solutions of confined and unconfined flow; seepage, erosion, piping and filter design; earth and rock fill dam construction and design; stability analyses. P. 340.

548. Numerical Methods in Geotechnical Engineering (3) II 1993-94 Brief statements and applications of numerical methods based on closed-form solutions, finite difference, finite element and boundary element methods for problems involving soil structure interaction such as piles, retaining walls, group piles, underground works; seepage; and consolidation. P. 340, 402 or 502.

552. Engineering Surveys (3) I Solar and Polar observations; mineral, public, and private land surveys; route surveying, curves, and earthwork; triangulation, photogrammetry, and modern engineering surveys. P. 251.

555. Irrigation Engineering (4) II (Identical with ABE. 555) P. C E 321 or A ME 331a

558. Drainage of Irrigated Lands (3) II 1993-94 (Identical with ABE. 558)

562. Bituminous Materials (3) II Manufacture and evaluation tests for the control of bituminous materials used in highway construction and maintenance. P. 340 or consult department before enrolling.

563. Traffic Engineering (3) I Methods for the efficient and safe operation of transport facilities through analysis of capacity, safety, speed, parking, and volume data. P. 360.

564. Airport Planning and Design (3) II Location, analysis and design of airports and airport facilities, including aircraft characteristics, site selection, configuration, capacity, access and terminals. Field trips. P. 360.

565. Project Planning and Modeling (3) II Use of systems analysis in contemporary planning, including consideration of social, environmental and physical constraints; study of general and special purpose manual and computer-based simulation and gaming as an engineering and planning tool. P. senior standing in civil engineering or consult with department. (Identical with PLNG 565)

568. Urban Transportation Planning (3) II Transportation planning in relation to urban development; techniques and procedures for developing long-range regional plans. P. 360 or consult department before enrolling. (Identical with PLNG 568)

573. Biodegradation of Hazardous Organic Compounds (2-3) I Chemical and microbiological considerations which affect the thermodynamics and kinetics of transformations of hazardous organic compounds in treatment facilities and in natural settings. 1R, 3L. P. 577, or consult with department.

574. Environmental Transport Processes (3) I Engineering concerns in toxic and hazardous waste management with focus on aspects of chemical transport between air, water and soil systems, and microbial degradation processes in natural and engineered environment.

575. Microbiology of Environmental Engineering (3) I Microbiological concepts and their application to natural and engineered systems for upgrading water and wastewater quality. 2R, 4L. P. 370.

576R. Chemistry of Environmental Engineering (3) I Chemistry of natural waters and water and wastewater treatment processes. Chemical thermodynamics, equilibria and kinetics are applied to environmental systems. P. CHEM 103B, MATH 254.

576L. Environmental Chemistry Laboratory (1) I Laboratory exercises emphasizing the chemistry of natural waters, water and wastewater including related analytical methods. 3L. CR, 576R.

577. The Physiological Bases of Microbial Treatment Processes (3) II Principles of bacterial physiology including morphology, metabolism and genetics. Applications of importance to waste treatment and environmental quality. P. 370, or consult with department.

578. Introduction to Hazardous Wastes (3) II Management, planning, legal and engineering aspects of liquid and solid hazardous waste treatment and disposal. P. 370 or consult department before enrolling.

579. Environmental Air Pollution (3) I Air pollution sources and pollutant control, with special consideration of the meteorological, urban, rural, industrial, and health aspects.

586. Fundamentals of Industrial Hygiene (3) I (Identical with OSH 586)

587. Advanced Industrial Hygiene and Safety (3) II (Identical with OSH 587)

596. Seminar
a. Environmental Engineering (1-3) I II
b. Geotechnical Mechanics Structures (1) I II [Rpt/2] I II (Identical with E M 596b)
c. Hydraulics and Water Resources (1) I II

597. Workshop
a. Advanced Cadastral Survey (1-4) II (Identical with RNR 597w)

*May be convened with 400-level course.


613. Theory of Elastic Stability (3) II 1993-94 Bending and buckling of prismatic bars, beams, rings, curved bars, thin shells, and thin plates under axial and lateral loads. P. 417 or E M 603 and C P. 402, or consult department before enrolling.

621. Sediment Transportation (2) II 1993-94 Erosion, transportation and deposition of sediments by flowing water; sediment properties and their measurement; bed load and suspended load movement; river behavior and control. P. 321.

622. Open-Channel Flow (3) II 1993-94 Continuity, energy and momentum principles applied to steady and unsteady flow in open channels; channel controls, transitions, flood routing, and models. P. 322.


624. Planning and Design of Multipurpose Water Resources Projects (3) I 1993-94 Design of water resource systems for surface water supply, flood control, hydropower and navigation, either as single purpose or as multipurpose projects; brief review of environmental, economic and legal aspects. Field trips. P. 321, 423 or 523.

632. Infrastructure Rehabilitation (3) II 1993-94 Status of infrastructure and causes of deterioration of constructed facilities. Strengthening of bridges and buildings. Application of advanced modern materials such as fiber composites in the design of new structures and rehabilitation of existing structures. P. 331, 336, 337.

633. Reinforced Concrete Members (3) II 1993-94 Inelastic behavior of beams and columns; short- and long-term beam deflections; corrosion, shear and torsion in beams; behavior under load reversals; analysis and design of beam to column connections and shear walls. P. 437 or departmental approval.

637. Soil-Structure Interaction (3) II 1993-94 Definition of soil-structure interaction, static and dynamic loading, analytic and computer solutions, two and three dimensional structure foundation combinations. P. 340, 548 or consent of instructor.

640. Advanced Soil Mechanics (3) I Site investigation and in situ testing; shear strength of sands and clays; interpretation of laboratory test results; consolidation theory: one-dimensional infinitesimal and finite strain; slope stability. P. 340.


645. Geoenvironmental Engineering (3) II 1993-94 Interaction of environment and geotechnology; physiochemical properties and mechanism of pollutant transport; effects on soil and foundation behavior and ground water, analytical and numerical modelling, design of geotechnical structures and waste contaminant systems. P. 340, 544 or consent of instructor.


674. Toxic and Hazardous Waste Treatment (3) II The process engineering fundamentals from which treatment strategies and process treatment trains can be synthesized to control toxic and hazardous wastes. Both traditional and emerging technologies will be considered. Emphasis will be placed on integrated water, air and land interfacial environmental interactions. Field trips, P, 574, or consult with department.

675L. Wastewater Treatment Laboratory (1) I Experiments in biological treatment of wastewater and anaerobic digestion designed to illustrate treatment principles. 3L. CR, 675R.

676L. Wastewater Treatment System Design Laboratory (1) II Experiments in advanced water treatment developed to illustrate design principles in the potable water production field. CR, 676R.

676R. Advanced Water Treatment System Design (3) II Design and operation of water treatment plants; physicochemical treatment processes for potable water production.

677L. Water Treatment System Design Laboratory (1) II Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

678L. Water Supply System Design Laboratory (1) I Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

679L. Water Supply System Design Laboratory (1) II Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

680L. Water Supply System Design Laboratory (1) III Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

681R. Advanced Water Treatment System Design Laboratory (1) IV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

682R. Advanced Water Treatment System Design Laboratory (1) V Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

683R. Advanced Water Treatment System Design Laboratory (1) VI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

684R. Advanced Water Treatment System Design Laboratory (1) VII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

685R. Advanced Water Treatment System Design Laboratory (1) VIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

686R. Advanced Water Treatment System Design Laboratory (1) IX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

687R. Advanced Water Treatment System Design Laboratory (1) X Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

688R. Advanced Water Treatment System Design Laboratory (1) XI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

689R. Advanced Water Treatment System Design Laboratory (1) XII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

690R. Advanced Water Treatment System Design Laboratory (1) XIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

691R. Advanced Water Treatment System Design Laboratory (1) XIV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

692R. Advanced Water Treatment System Design Laboratory (1) XV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

693R. Advanced Water Treatment System Design Laboratory (1) XVI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

694R. Advanced Water Treatment System Design Laboratory (1) XVII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

695R. Advanced Water Treatment System Design Laboratory (1) XVIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

696R. Advanced Water Treatment System Design Laboratory (1) XIX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

697R. Advanced Water Treatment System Design Laboratory (1) XX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

698R. Advanced Water Treatment System Design Laboratory (1) XXI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

699R. Advanced Water Treatment System Design Laboratory (1) XXII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

700R. Advanced Water Treatment System Design Laboratory (1) XXIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

701R. Advanced Water Treatment System Design Laboratory (1) XXIV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

702R. Advanced Water Treatment System Design Laboratory (1) XXV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

703R. Advanced Water Treatment System Design Laboratory (1) XXVI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

704R. Advanced Water Treatment System Design Laboratory (1) XXVII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

705R. Advanced Water Treatment System Design Laboratory (1) XXVIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

706R. Advanced Water Treatment System Design Laboratory (1) XXIX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

707R. Advanced Water Treatment System Design Laboratory (1) XXX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

708R. Advanced Water Treatment System Design Laboratory (1) XXXI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

709R. Advanced Water Treatment System Design Laboratory (1) XXXII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

710R. Advanced Water Treatment System Design Laboratory (1) XXXIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

711R. Advanced Water Treatment System Design Laboratory (1) XXXIV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

712R. Advanced Water Treatment System Design Laboratory (1) XXXV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

713R. Advanced Water Treatment System Design Laboratory (1) XXXVI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

714R. Advanced Water Treatment System Design Laboratory (1) XXXVII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

715R. Advanced Water Treatment System Design Laboratory (1) XXXVIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

716R. Advanced Water Treatment System Design Laboratory (1) XXXIX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

717R. Advanced Water Treatment System Design Laboratory (1) XL Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

718R. Advanced Water Treatment System Design Laboratory (1) XLI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

719R. Advanced Water Treatment System Design Laboratory (1) XLII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

720R. Advanced Water Treatment System Design Laboratory (1) XLIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

721R. Advanced Water Treatment System Design Laboratory (1) XLIV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

722R. Advanced Water Treatment System Design Laboratory (1) XLV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

723R. Advanced Water Treatment System Design Laboratory (1) XLVI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

724R. Advanced Water Treatment System Design Laboratory (1) XLVII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

725R. Advanced Water Treatment System Design Laboratory (1) XLVIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

726R. Advanced Water Treatment System Design Laboratory (1) XLIX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

727R. Advanced Water Treatment System Design Laboratory (1) L Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

728R. Advanced Water Treatment System Design Laboratory (1) LI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

729R. Advanced Water Treatment System Design Laboratory (1) LII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

730R. Advanced Water Treatment System Design Laboratory (1) LIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

731R. Advanced Water Treatment System Design Laboratory (1) LIV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

732R. Advanced Water Treatment System Design Laboratory (1) LV Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

733R. Advanced Water Treatment System Design Laboratory (1) LVI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

734R. Advanced Water Treatment System Design Laboratory (1) LVII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

735R. Advanced Water Treatment System Design Laboratory (1) LVIII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

736R. Advanced Water Treatment System Design Laboratory (1) LIX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

737R. Advanced Water Treatment System Design Laboratory (1) LX Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

738R. Advanced Water Treatment System Design Laboratory (1) LXI Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.

739R. Advanced Water Treatment System Design Laboratory (1) LXII Experiments in advanced water treatment designed to illustrate principles in the potable water production field. CR, 676R.
the critical use of source material, the development of independent thought and the production of the finished, written product. P, 340a or 340b.

554.* Greek and Roman Sculpture (3) A survey of the development of classical sculpture from the eighth century B.C. to circa 300 A.D. P, 340a-340b. (Identical with ARH 554)

556.* Greek and Roman Painting (3) Greek vase painting from the Dipylon vases of the geometric period in Athens to the Orientalizing animal styles of Corinth and the black and red figured Attic style. Also, survey of ancient Roman painting and mosaics. P, 340a-340b. (Identical with ARH 556)

557.* Greek Architecture (3) A survey of the architecture and architects of Greece from the Neolithic to Roman periods including such sites as Nea Nikomedia, Aegina, Lerna, Tiryns, Mycenae, Athens and Corinth. P, 340a-340b. (Identical with ARH 557)

558.* Greek and Roman Provincial Archaeology (3) Survey of classical archaeology in ancient Tunisia, Cyprus, Portugal and Turkey. P, 340a or 340b.

561.* Greek Pottery 1200-400 b.c. (3) The development of Greek pottery from the collapse of the Mycenaean empire to the close of the classical period. Special attention to shapes, decoration, function, and artistic and technical skills. (Identical with ANTH 561 and ARH 561)

563.* Classical Field Archaeology (6) [Rpt./1] Field training and lecture program for students beginning in archaeology; includes trench supervision, stratigraphy, locus theory, and oral and written reports on field techniques. Offered on several archaeological sites in the Mediterranean area. P, consult department before enrolling.

564. Topics in Ancient Mediterranean Archaeology (3) Research papers and oral presentations on different aspects of Greek and Roman archaeology; preparation in writing scholarly articles for refereed journals. P, 340a or 340b.

581.* Archaic Greek Sanctuaries (3) Archaeology of the sanctuary sites from the Archaic Period in Greece, both those which became panhellenic and those associated with individual states. Relationships between the polis and the local sanctuary. (Identical with ANTH 581)

584.* Roman Art and Architecture (3) The origin and development of Italian art and architecture from Etruscan beginnings through the Roman Empire. P, ARH 117, 118, or 6 units of ancient history. (Identical with ARH 584)

587. Testing and Evaluation in Foreign/Second Language Programs (3) (Identical with GER 587)

596. Seminar a. Ancient Art and Archaeology (3) [Rpt./30 units] (Identical with ARH 596a)

*May be convened with 400-level course.

Classical Literature and Civilization (CLAS)

510a-510b. Classical Philology (3) Introduction to the various disciplines of classical scholarship: philology, textual criticism, paleography, papyrology, archaeology.

570.* Greek Philosophy (3) [Rpt./1] (Identical with PHIL 570)

572a-572b.* Ancient Philosophy (3-3) [Rpt.] (Identical with PHIL 572a-572b)

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with GREEK 585)

588.* History of Byzantium (3) (Identical with HIST 588)

*May be convened with 400-level course.

695. Colloquium f. Advanced Studies in Ancient History (3) [Rpt./6 units] II (Identical with HIST 695f, which is home)

Greek (GRK)

502.* Greek Reading Course (3) [Rpt.] Readings in major Greek authors including Homer, Plato, and the historians and dramatists. P, 3 units of 400-level Greek.

512.* Readings In Greek Philosophy (3) [Rpt./1] Extensive readings in one of the following areas of Greek philosophy: the pre-Socratics, Plato's ethics and epistemology, Aristotle's Nicomachean Ethics. P, 3 units of 400-level Greek. (Identical with PHIL 512)

521.* Greek Lyric Poetry (3) [Rpt./1] Study in Greek of the early Greek Lyric writers from Archilochus to Bacchylides, including Pindar. P, 3 units of 400-level Greek.

522.* Readings in Greek Drama (3) [Rpt./1] Close reading in Greek of either (1) tragedy— one play each by Aeschylus, Sophocles and Euripides or (2) comedy—two plays of Aristophanes, one of Menander. P, 3 units of 400-level Greek.

524.* Homer (3) [Rpt./1] Close reading of selections from the Iliad and Odyssey in Greek and an introduction to the critical secondary literature.

530.* Readings in the Greek Historians (3) [Rpt.] Selections from Herodotus and Thucydides with an introduction to the critical secondary literature. Readings in Greek. P, 3 units of 400-level Greek.

531.* Greek Orators (3) [Rpt.] Readings in Greek from Lysias, Isocrates and Demosthenes as sources for ancient rhetoric, politics, and private life. P, 3 units of 400-level Greek.

532.* Literature of Archaic Greece (3) [Rpt.] Readings in Greek from Hesiod and the early lyric poets. The agricultural perspective and the anti-heroic ideal. P, 3 units of 400-level Greek.

596. Seminar a. Topics in Ancient Greek Literature (3) [Rpt./30 units]

*May be convened with 400-level course.

Latin (LAT)

501.* Latin Reading Course (3) [Rpt./1] Readings in one of the following: epic, lyric, drama, history, oratory, satire, epistles, novel, philosophical, technical or medieval literature. P, 3 units of 400-level Latin.

503.* Late Antique Literature (3) [Rpt./1] II S Selections from genres and/or authors, both Christian and non-Christian, from the late antique period. P, 3 units of 400-level Latin.


513.* Augustan Literature (3) [Rpt./1] Readings from a major writer or writers of the Augustan Age. P, 3 units of 400-level Latin.

514.* Medieval Latin (3) Survey of Latin literature during the thousand years between the end of the classical period and the beginning of the Renaissance. Readings in Latin. P, 3 units of 400-level Latin.

515.* Latin Love Elegy (3) [Rpt./1] Reading in the Latin texts of Ovid, Tibullus and Propertius. P, 3 units of 400-level Latin.


525.* Cicero (3) [Rpt./1] The life of Cicero illustrated by means of close reading of selected works in Latin (pro Caelio, selections from the Philippiics, the Verrine Orations) as well as selections from his letters. P, 3 units of 400-level Latin.

526.* Roman Historians (3) [Rpt.] Readings in Latin from the Roman historians and biographers. Selections from Livy, Caesar, Tacitus, or Suetonius. May be repeated without duplication of readings. P, 3 units of 400-level Latin.

528.* Silver Age Latin (3) [Rpt.] Readings from Latin writers of the early Empire. Readings will be in Latin. P, 3 units of 400-level Latin.

596. Seminar a. Topics in Latin Literature (3) [Rpt./30 units]

*May be convened with 400-level course.

Cognitive Science

Psychology Building, Room 312
(602) 621-2065
Graduate Interdisciplinary Program in Cognitive Science
Committee:
Professors Merrill F. Garrett, Chair (Linguistics), Carol A. Barnes (Psychology), Robert C. Cummins (Philosophy), Richard A. Demers (Linguistics), Kenneth I. Forster (Psychology), Alvin L. Goldman (Philoso-
Communication (COMM)

Speech Building, Room 209
(602) 621-1366

Professors William D. Crano, Head, Judee K. Burgoon, Michael H. Burgoon, Henry L. Ewebank, Klonda Lynn (Emerita), Alethea S. Mattingly (Emerita)

Associate Professors David B. Buller, James W. Davis (Emeritus), Sally A. Jackson, Curtis S. Jacobs, Henry C. Kenski, Robert W. Sankey, David A. Williams

Assistant Professor Calvin K. Morrill

The department offers programs leading to the Master of Arts degree and the Doctorate in Communication degrees with a major in communication. Work leading to the Master of Education degree with a major in communication also is offered in cooperation with the College of Education.

Four program options are available for the Master of Arts degree, the departmental program with a thesis or non-thesis option and the interdisciplinary program with thesis or nonthesis. The thesis option requires a minimum of 31 units, including four thesis units; 36 units are required in the nonthesis alternative. Those electing a departmental program may count a maximum of three units taken outside the department toward the required minimum. Those electing an interdisciplinary program (e.g., organizational communication concentration) must take a minimum of nine units outside the department. These nine units must include a thesis. The program option is strongly encouraged for master's students planning to enter a doctoral program. For those interested in applied programs that will prepare them for positions in industry and government, flexibility in designing an individual programs exists.

Doctoral students must complete at least 36 units of course work in the major (including up to nine units from the master's degree), one or two minors, plus the dissertation, and must demonstrate proficiency in a scholarly research tool. A minimum of six units of independent study, not including those counted toward the Master of Arts degree, may be included in the required minimum for the major and minor.

Students in the master's program are required to complete courses 610, 620, and 660 plus an additional research methods course. Doctoral students are required to complete courses 610, 620, 660 and 670. For both masters' and doctoral students, all courses are counted toward the minimum hours requirements must carry a grade of B or better (or P or better for S/P Special Grades). In addition to the materials required by the Graduate College, applicants for admission must file with the department a departmental application form, three letters of recommendation, and Graduate Record Examination scores that are no more than five years old. Applicants for the doctoral program must submit a master's thesis or other evidence of scholarly writing.

503* Theories of Small Group Communication (3) I II Theory and research on social control and deviance in groups from the perspective of communication behavior.

504* Theories of Mass Communication (3) II An in-depth analysis of theories of the social effects of various mass media sources on society.

509* Struggle for the Presidency (3) I Examination of the campaign strategies and tactics of those seeking the nation's most powerful office from 1960 to the present. (Identical with POL 510)

511* Communication and Conflict Management (3) I Consideration of theory and research pertaining to the handling of conflict across diverse contexts.

514* Verbal Communication (3) I II Theory and research on verbal messages. Topics include patterns of conversational interaction, processes of message construction and interpretation, functions and contexts of messages. P. 300.

515* Nonverbal Communication (3) I II Theory and research on nonverbal communication codes (kinesics, touch, voice, appearance, use of space, time and artifacts) and social functions (impression formation and management, relational communication, emotional expressions, regulation of interaction, social influence).

517* Relational Communication (3) I The relational communication process and messages people use to define interpersonal relationships, including dominance-submissive ness, affection, involvement and similarity. P. 104.

520* Communication and the Legal Process (3) I Presents a number of accomplishments and challenges in the social scientific study of law, with special emphasis on the effects of communication and social structure on the legal processes. (Identical with SOC 520)

521* Political Campaign Communication (3) I Investigation and analysis of communication principles and practices in contemporary campaigns for elective office.

522* Presidential Leadership and Communication (3) I Examination of presidential leadership and communication strategies of the modern presidents from Kennedy to the present.

523* Topics in Rhetorical Theory and Criticism (3) [Rpt./1] Intensive reading and analysis of the works of major rhetorical theorists. Each semester will focus on a specific era or perspective.

524* Media and Politics in America (3) I Survey of field; media in political campaigns; media coverage of leaders, issues, and institutions; leadership strategies to influence media.

525* Scientific Argument in Public Discourse (3) I Advanced argumentation theory focused on examination of scientific argument in public decision-making. Topics include general theory of fallacies and special fallacies related to scientific reasoning.

528* Communication Research Methods (3) I II Theories of communication and their research backgrounds; research methodology in communication behavior studies.

550* Communication and Cognition (3) I II Interrelations between human communication and cognitive processes. Emphasis on theory and research in social cognition.
Comparative Cultural and Literary Studies (CCLS)
1239 North Highland Avenue, Building 431a
(602) 626-8693

Graduate Interdisciplinary Program in Comparative Cultural and Literary Studies Committee:
Professors Barbara A. Babcock, Chair (English), J. Douglas Canfield (Eng-

lish), Jane H. Hill (Anthropology), Herbert N. Schneider (English), Joseph (Jay) Stauss (Family and Consumer Resources), Charles M. Tatum (Spanish and Portuguese)
Associate Professors Karen S. Anderson (History), Melanie L. Walleddorf (Marketing), Marvin Waterstone (Geography and Regional Development) Assistant Professor Eileen R. Meehan (Media Arts)

Comparative Cultural and Literary Studies explore similarities and differences within and among national cultures and literatures, as well as in the work of individuals, using a variety of methods from the humanities and social sciences. Such interdisciplinary studies focus on the production, circulation, and interpretation of meaning and value in all cultural activity.

The Program offers the M.A. and Ph.D. degrees with a major in comparative cultural and literary studies. Students pursue a core of theoretical courses and study at least two primary discourses. Courses are taught by faculty from a variety of cooperating departments and programs. A list of affiliated faculty is available from the program office. Discourses may be, but are not limited to, literary discourses in the original language. Examples of non-literary discourses include anthropology, culture and technology, cultural geography, media arts, art history, and science, among others. Ph.D. students minor in a third discourse, which may be another literature or another discipline/program of study in the human sciences. The master's degree is considered primarily as leading to the Ph.D. degree.

Admission to the program is based on the following kinds of evidence: (1) excellent undergraduate performance in language, literature, and/or another form of discourse (preferably majors and minors) as indicated by a transcript; (2) three letters of recommendation from persons familiar with the student's performance in these areas; (3) an example of the student's writing on a literary or cultural topic. For students applying for the doctoral program, this must be an article-length and article-quality piece that will serve as a qualifying exam.

In addition, students may wish to submit TOEFL scores. Foreign students must submit TOEFL scores.

Master of Arts: Degree requirements include at least 30 units: 18 units in graduate-level courses in at least two disciplines; no more than 9 units may be taken in any one discipline; 3 units of 503; 3 units of 549a or 549b; 3 units of 550a or 550b; 3 units of independent study in preparation for the master's examination, a final examination (consisting of an article-length, article-quality paper presented to faculty and students) evaluated by the executive committee; augmented by at least one specialist in the area of the paper.

Doctor of Philosophy: Degree candidates are required to take at least 42 units for the major, 18 units of dissertation, and a minor. Course requirements include: 3 units of 503; 3 units of 549a or 549b; 6 units of 550a-550b; 3 units of 696 and an additional 3 units of 694 or 695. Course work is aimed at preparing for a preliminary exam in the student's chosen discourses and theoretical specialization.

503. Introduction to Comparative Cultural and Literary Studies (3) I Strategies of interpretation taught through practical critique.
549a-549b. Folklore (3-3) (Identical with ENGL 549a-549b)
550a-550b. Modern Theories of Cultural Studies (3-3) Historical precedents and contemporary thought in cultural studies from sociological to feminist theory. 550a: from such theorists as Marx, Bakhtin, and Foucault; 550b: from Frankfurt school to contemporary theorists of political economy.
561. Linguistics and the Study of Literature (3) II 1994-95 (Identical with LING 561)
596. Seminar a. Comparative Cultural and Literary Studies (3) [Rpt/4] I II
b. Organizational Communication (3) [Rpt/3] II
c. Information Processing and Management (3) [Rpt/3] II
d. Interpersonal Communication (3) [Rpt/3] II
e. Organizational Communication (3) [Rpt/3] I
f. Social Influence (3) [Rpt/3] II
g. Linguistic Investigations and Applications (3) [Rpt/3] II I I (Identical with LING 663, which is home)
h. Message Analysis (3) [Rpt/3]

Computer Science (CSC)
Gould-Simpson Building, Room 721
(602) 621-6613

Associate Professors Saumya K. Debray, Peter J. Downey, Stephen R. Mahaney, Larry L. Peterson, Richard D. Schlichting, Richard T. Snodgrass, Assistant Professors Mary L. Bailey, Sampath K. Kannan, Todd A. Proebsting

The Department of Computer Science offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in computer science. The Department's programs prepare graduate students for positions in the design and development of computer systems and applications in business and industry and for scientific positions in industrial or academic computing re-
search. Areas of research interest within the department currently include programming languages, operating systems, distributed processing, theory, analysis of algorithms, databases, computer networks, and computer graphics.

Applicants for admission should hold an undergraduate degree in computer science or a related field. In addition to the application materials submitted to the Graduate College, applicants must submit to the department scores from the General Test of the Graduate Record Examination. Scores for the Computer Science Subject test are strongly recommended. The department requires that two letters of recommendation be submitted.

A brochure describing admissions requirements and degree programs in detail is available from the department.

Master of Science: 30 units of graduate credit are required, including one course in each of the core areas: systems (552, 576), programming languages (520, 553), and theory (545, 573); four specialization courses; and at least one advanced topics course. A thesis is not required, but with departmental approval a student may elect to submit one.

Doctor of Philosophy: Doctoral students must complete 36 units of graduate credit in the major including the M.S. core, 520, 545, and 576, and at least two advanced topics courses. Work in a related minor field is required. There is no foreign language requirement.

Doctoral candidates majoring in other disciplines may minor in computer science by completing a sequence of courses and examinations set by the department.

502. Mathematical Logic (3) I 1993-94 (Identical with MATH 502)

520. Principles of Programming Languages (3) I Important programming language concepts, including types, control and data abstraction, denotational semantics, declarative and object-oriented languages, implementation issues. P. 453.

521a-521b. Advanced Systems Modeling and Simulation (3-3) (Identical with MIS 521a-521b)

522. Principles of Concurrent Programming (3) II Fundamental concepts of concurrent programming; synchronization mechanisms based on shared variables and message passing; systematic development of correct programs; paradigms for parallel and distributed programming. P. 344, CR452.

525. Principles of Computer Networking (3) II Theory and practice of computer networks, emphasizing the principles underlying the design of network software and the role of the communications system in distributed computing. Topics include routing, flow and congestion control, multicast, data representation, and RPC. P. 452.

530. Case Studies in Software Design (3) II Techniques and tools for program design and implementation, especially of large programs. Specification, abstraction, verification, maintenance, performance tuning. Includes substantial programming. P. 237 or ECE 271b; 342.


541a-541b. Computer-Aided Information System Analysis and Design (3-3) (Identical with MIS 541a-541b)

543. Theory of Graphs and Networks (3) II (Identical with MATH 543)

545. Design and Analysis of Algorithms (3) I Time, space complexity; recurrences; algorithm design techniques; lower bounds; graph, matrix, set algorithms; sorting; fast Fourier transform; arithmetic complexity; intractable problems. P. 445, 473, MATH 362.

550. String and List Processing (3) II Data representation, pattern matching, programming techniques; applications. P. 372, 430, 344.

552. Advanced Operating Systems (3) I Operating system design, implementation and modeling; deadlock and memory management models; protection mechanisms; operating systems for parallel and distributed systems. P. 452.


571a-571b. Digital Systems Design (3-3) (Identical with ECE 571a-571b)

572a-572b. Continuous-System Simulation (3) I (Identical with ECE 572a-572b)

573. Theory of Computation (3) II Chomsky hierarchy, undecidability; general recursive functions; recursion theory; computational complexity theory; NP-complete and provably intractable problems. P. 473. (Identical with MATH 573)

574a-574b. Computer-Aided Logic Design (3-3) I (Identical with ECE 574a-574b)

575a-575b. Numerical Analysis (3-3) (Identical with MATH 575a-575b)


578. Computational Methods of Algebra (3) II (Identical with MATH 578)

579. Game Theory and Mathematical Programming (3) I 1991-92 (Identical with MATH 579)

588. Computational Linguistics (3) I (Identical with LING 588)

*May be conveined with 400-level course.

620. Advanced Topics in Programming Languages (3) [Rpt./12 units] I Design, implementation, and compilation of programming languages; specific topics to be determined by current literature and faculty and student interest.

630. Advanced Topics in Software Systems (3) [Rpt./12 units] I Problems in design and development of large systems of programs; specific topics to be determined by current literature and faculty and student interest.

645. Advanced Topics in Algorithm Analysis (3) [Rpt./12 units] I Design and analysis of algorithms; specific topics to be determined by current literature and faculty and student interest.

652. Advanced Topics in Operating Systems (3) [Rpt./12 units] I Operating system design, development, analysis, and performance; specific topics to be determined by current literature and faculty and student interest.

673. Real-Time Distributed Processing Systems (3) II (Identical with ECE 673)

674. Test Generation for Automata (3) I (Identical with ECE 674)

676. Seminar a. Current Computing Research (1-3) [Rpt./8] II S

Counseling and Guidance
(See Family and Consumer Resources)

Creative Writing
(See English)

Dance (DNC)
Gittings Building, Room 14
(602) 621-4698
Committee on Dance
Professor John M. Wilson
Associate Professors Jory Hancock, Chair, Nina Janik
Assistant Professors Ellen R. Bromberg, Melissa Lowe, Michael L. Williams

The Committee on Dance offers a dance concentration within the theatre arts major, Master of Arts degree, in cooperation with the Department of Theatre Arts. Interested students should consult the Committee on Dance.

501. Advanced Floor Barre (1) [Rpt/ 4 units]
I I Develops deep strength, flexibility and
alignment specific to all forms of dance. Building on the concepts presented in 201, this course is geared to the more advanced student, presenting exercises that are more rigorous and complex in nature. 25, P. 201.

539a-539b.* Advanced Pointe Technique (1-1) [Rpt/4 units] II 539a: Barre work; continuing development of strength, speed, and stamina. Introduction of advanced barre combinations. Center work; allegro en pointe, also adagio, and pirouettes and consecutive turns. 539b: Continuation of 539a with increasing difficulty and complexity in the enchainments. 25, P, audition.

540a-540b.* Ballet Technique III (2-3) [Rpt/12 units] P, 340b. Hancock

541a-541b.* Modern Dance Technique III (3-3) II [Rpt/12 units] P, 341b. Bromberg

543. Dance Ensemble (2) [Rpt/1] II Rehearsal methods, repertorial development, and performance of dance with particular emphasis on ensemble. 45, P, repertory audition; intermediate level in modern and ballet (340a-b, 341a-b).

545a-545b.* Advanced Choreography (2-2) 545a: Movement, motif development for solo and group composition. 545b: Balancing the intuitive and intellectual components of the creative process to create meaningful and well-crafted dances. 45, P, 245b. Bromberg

546. Dance Program Administration (3) II 1994-95 Historical and current factors affecting career development in dance and dance-related fields; practical organization of programs. (Identical with T AR 546) Wilson

550. Literary Resources for Choreography (3) II 1993-94 Studies in primary world literature, drama, and in psychology of personages as sources for choreographic themes; presentation of motifs and scenario. 65, P, 445. (Identical with T AR 550) Wilson

551a-551b.* Ballet Repertoire (2-2) II [Rpt/12 units] Repertoire from romantic, classical and contemporary ballets including works by Bourneville, Petipa, Ashton, Balanchine, Christensen and others. 1R, 3S, P, 340 or by audition. Hancock

560.* Ballet Technique for Men (1) [Rpt/2 units] I Emphasis on physical conditioning as well as adagio movement; various pirouette, grand allegro, elevations using battery in combinations focusing on male performance. P, Intermediate Ballet. 25.

595. Colloquium
   a.* Evaluation of Dance and Body Technique (3) I P, intermediate level ballet or modern dance techniques. (Identical with T AR 595a)

596. Seminar
   a.* Dance-Related Art Forms (3) II 1994-95 (Identical with T AR 596d)

*May be convened with 400-level course.

697. Workshop

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### East Asian Studies

**EAS/CHN/JPN**

Franklin Building, Room 404 (602) 621-7505

Professors Brian E. McKnight, Head, Gail L. Bernstein (History), Anoop Chandola, Robert M. Gimello, Earl H. Pritchard (Emeritus), William R. Schultz (Emeritus), Jing-shen Tao, Allen S. Whiting (Political Science)

Associate Professors Marie C. Chan, Charles H. Hedinke, Ronald C. Miao, John W. Olsen (Anthropology), Barbara N. Sands (Economics), Chia-lin Pao-Tao

Assistant Professors J. Philip Gabriel, Donald J. Harper, Elizabeth G. Harrison, Kimberly A. Jones, Donald Kirihara (Media Arts), Feng-hsi Liu, James Milward (History), Haru Yamada

The Department of East Asian Studies offers programs leading to the Master of Arts and Doctor of Philosophy with majors in East Asian studies. Graduate training in East Asian studies affords students important opportunities for careers in teaching, international business, international law, government and diplomatic service, and journalism.

Graduate programs on the master's level are available with concentrations based either in traditional academic disciplines or in specially constructed general study areas related to East Asia. The doctoral programs are rigorously based in traditional academic disciplines. Master's students must complete a minimum of 30 graduate units and a thesis, or 32 units and a departmental paper. Disciplinary concentrations, often in preparation for further Ph.D.-level study, are currently offered in a number of fields in Chinese history, linguistics, literature, religion and thought, and in Japanese literature as well as linguistics and language pedagogy. A general master's study program may include a variety of courses from East Asian studies and other departments in both Chinese and Japanese areas. To ensure programmatic integrity, the general program must be devised in consultation with appropriate faculty. The general program is often suitable for preprofessional training. Doctoral study must be focused on Chinese history, linguistics, literature, religion and thought or on Japanese language pedagogy, linguistics, literature or religion; minor fields are usually selected from other supporting disciplines. Subjects in East Asian studies may serve for Ph.D. fields for students earning Ph.D. degrees in other departments.

Admission requires adequate preparation, although admission with some deficiencies is possible. The department bases admission into the master's and doctoral programs upon the grade-point average, the applicant's statement of purpose, two letters of recommendation, and GRE scores. Foreign students must achieve a minimum score of 550 on the TOEFL. Applicant objectives must also correspond to the department's programmatic capabilities. Contact the East Asian Studies' graduate secretary for further details.

Courses related to East Asia in addition to the courses listed below may be taught in the Departments of Anthropology, Economics, History, Media Arts and Political Science.

### East Asian Studies (EAS)

527a.* The Prehistory of East Asia (3) I (Identical with ANTH 527a)

545.* Hindu Mysticism (3) II Introduction to the major concepts and practices of Hindu mysticism, including yoga techniques, rites, symbols, and myths. (Identical with RELI 545)

551.* The United States and East Asia: 1940 to the Present (3) II 1994-95 (Identical with HIST 551)

552.* Hindu Literature (3) I Introduces major literary works with ancient Sanskrit genres. Selections from the Vedas, epics, Puranas and other classics in English translation.

563.* Asian Marxism (3) II Comparative historical study of several Marxist revolutionary movements. (Identical with HIST 563)

564.* International Relations of East Asia (3) II (Identical with POL 564)

587. Testing and Evaluation in Foreign/Second Language Programs (3) (Identical with GER 587)

587a-587b.* History of East Asian Buddhism (3-3) Buddhism in China, Korea and Japan with emphasis on the relationship between East Asian Buddhist thought and practice and the various historical contexts in which they emerged.

589.* Women in East Asia (3) I (Identical with HIST 589)

596. Seminar
   a. Topics in East Asian Buddhism (3) 1994-95 P, reading knowledge of Chinese and/or Japanese; EAS 487a-487b/587a-587b or the equivalent. *May be convened with 400-level course.*

### Chinese Studies (CHN)


519." Linguistic Structure of Modern Chinese (3) Linguistic study of the phonological, morphological, and syntactic systems of modern Chinese, with particular attention to linguistic analysis. (Identical with LING 519)

520." Linguistic Structure of Modern Chinese (3) II Linguistic study of the phonological, morphological, and syntactic systems of modern Chinese, with particular attention to linguistic analysis. P, 419/519. (Identical with LING 520)

521. Resources and Methods in Sinology (3) II Introduction to and exercises in the use of standard sinological reference and research resources. P, 523.


523." Readings in Classical Chinese Philosophical Texts (3) II Introduction to Confucian, Taoist, and legalistic military philosophical texts. P, 422/522.

527." The Archaeology of Pre-Han China (3) II (Identical with ANTH 527b)

529." Chinese-American Literature 1960-Present (3) Studies of the significant literary works by Americans of Chinese descent between 1960 and the present. (Identical with ENGL 529).

530." Law in Traditional China (3) I Survey of law in traditional China, including examination of dispute resolution processes, the development of written law codes, formal judicial procedures, the theory and practice of punishment, crime and criminals, and the social role of legal process as reflected in civil law disputes (over such issues as marriage, divorce, and property exchanges, and inheritance). P, 531.

540." Chinese Calligraphy (2) [Rpt.] I Theory, practice, and aesthetics of Chinese brush writing, with emphasis on individual training and development.

541. Chinese Historical Linguistics (3) I Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P, 402 and a course in general linguistics.

542. Chinese Historical Linguistics (3) II Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P, 541.


547. Readings in Classical Chinese Prose (3) [Rpt./2] I Readings in selected texts from literary, philosophical, and historical traditions; includes selections from the Five Classics and the great prose masters of the Han-Qing. Variable content. P, 423/523.


556." Modern Chinese Foreign Relations (3) II (Identical with POL 560)

568." Women in China (3) I Analysis of the role of women in Chinese society with equal emphasis on traditional and modern periods. P, 575a-575b-575c-575d-575e.

576.* Modern Chinese History (3) Historical survey of the period since 1911 which examines the revolutionary developments shaping contemporary China. (Identical with HIST 576)

582." Social History of China (3) Formation of ancient Chinese society; organization of families and clans; social stratification, mobility, conflict, and control in traditional China; and transformation from traditional to modern society. (Identical with HIST 582)

583." Confucianism: The Classical Period (3) (Identical with RELI 583)

584." Confucianism: The Neo-Confucian Tradition (3) (Identical with RELI 584)

595. Colloquium
a. Readings in Chinese History (3) [Rpt./12]

596. Seminar
b. Ancient Chinese Philosophy (3) [Rpt./2] II P, 423/523
c. Classical Chinese Literature (3) [Rpt./1] II
g. Modern Chinese Literature (3) [Rpt./1] II
h. Premodern Chinese History and Politics (3) [Rpt./1] II
i. Modern Chinese History and Politics (3) [Rpt./1] II

*May be convemed with 400-level course.

Japanese Studies (JPN)


505. Classical Japanese (3) I Introduction to classical Japanese grammar and to writing styles used from the 8th century through medieval times. P, grade of B or higher in JPN 416/516 or consent of instructor.

511.* Introduction to Japanese Linguistics (3) I Phonology, morphology, syntax, pragmatics, and sociolinguistics of the Japanese language. (Identical with LING 511)


520." Japanese Discourse (3) I Introduction to Japanese discourse which integrates approaches used in linguistics and literary criticism. P, background in communication, literature, linguistics or Japanese language.

521." Advanced Readings in Japanese (3) I Reading and discussion in Japanese of a variety of advanced-level materials, including newspaper articles, short articles, and poetry. P, 416/516 or instructor's permission.


536." Japanese Sociolinguistics (3) [Rpt./1] I Introduction to Japanese sociolinguistics; pragmatics, conversation analysis, discourse analysis, variation theory, ethnography of speaking and ethnomethodology. P, 202 or instructor's permission. (Identical with ANTH 536, ENGL 536 and LING 536).


574a-574b-574c.* History of Japan (3-3-3) (Identical with HIST 574a-574b-574c)

595.' Colloquium
a. Japan (3) [Rpt./2] I II

596. Seminar
a. * Japanese Literature (3) [Rpt./3] I II
b. Topics in Japanese Linguistics (3) [Rpt./2] II P, 411 or 511 (Identical with LING 596c)

599.' Japanese History (3) [Rpt./1] II

*May be convemed with 400-level course.

Ecology and Evolutionary Biology (ECOL)

Biological Sciences West Building
Room 310
(602) 621-1588

Professors Margaret G. Kidwell, Head, William A. Calder, III, E. Lendell Cockrum (Emeritus), William B. Heed
The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees in ecology and evolutionary biology and in botany. Concentrations are available in plant ecology, systematics and evolution; evolutionary theory; ecological and molecular genetics; environmental physiology; marine biology; animal behavior; population and community ecology; vertebrate biology and systematics; evolutionary morphology; and theoretical and mathematical biology. The department maintains excellent collections of fishes, amphibians, reptiles, birds, and mammals. An extensive herbarium is shared with the College of Agriculture. Field work is facilitated by a Marine Biology Station at Puerto Peñasco, Sonora, Mexico, and by the availability of the Coronado Ranch in the Chiricahua Mountains, the Southwestern Research Station, Portal, Arizona, the Research Ranch, Elgin, Arizona, and the Desert Laboratory on Tumamoc Hill, Tucson, Arizona.

Applicants are required to furnish the department with completed departmental application forms, copies of scores on the Aptitude and Advanced (any discipline) tests of the Graduate Record Examination, copies of transcripts of all college work, copies of GRE scores (in addition to those required by the Graduate College), and three letters of recommendation from persons qualified to evaluate the applicant's scholarly potential. Applications should be submitted by January 15; admission is normally approved only for students beginning their graduate studies with the fall semester.

Particular emphasis is placed on the student's ability to formulate and pursue original research problems. One course, Research in Ecology and Evolution (610A-610B), is required of all new graduate students. The remainder of the program is designed to meet the individual needs of each student.

In addition to the courses listed below, the department offers courses in quantitative genetics, phylogenetic systematics, evolutionary morphology, plant physiological ecology, biological rhythms, and approaches to problem solving in biology.

500A-500B. Advanced Topics in Ecology and Evolutionary Biology (4-4) 500A: Introduction to graduate study in ecology and evolutionary biology, via discussion of ongoing faculty research interests. P, 435. 500B: Introduction to field research methods in ecology. 3R, 3L. Field trips.


503R. Biology of Animal Parasites (3) (Identical with VSC 503R)

504. Plant Evolutionary Genetics (3) P, 12 units of biology.


510. Research Design and Analysis (3) I Description of fire and analysis for ecology, behavior, and morphology; inference and hypothesis tests; exploratory statistics.

511. Insect Behavior (3) II 1993-94 (Identical with ENTO 511)

512. Plants Useful to Man (2) S Lecture-demonstration course for teachers and others wishing information on the uses of plants: foods and food plants, medicinal plants, plants and industry, plants in textiles and other manufacturers.

514. Plants of the Desert (2) S Designed for teachers and others wishing to become familiar with common native and cultivated plants; identification, ecology, and uses.

516. Computer Analysis of Sequences (3) II (Identical with MCB 516)

518A-518B. Scientific Illustration (2 to 4 to 4) [Rpt.] I Graphic arts techniques to meet the career demands of students. 518A: Illustration. 518B: Photography. Consult department before enrolling.

519. Molecular Evolution and Genome Organization (3) I 1994-95 A rigorous and comprehensive survey of the molecular and evolutionary details of genome organization. P, 320, year of calculus.

520. Evolutionary Quantitative Genetics (4) II Rigorous coverage of the inheritance and evolution of quantitative characters. Theory, estimation and design issues, and experimental results given equal coverage. P, Calculus.

521. Philosophy of the Biological Sciences (3) I 1993-94 (Identical with PHIL 521)

523. Cytogenetics (3) II Investigation into the structure and function of chromosomes and their role in heredity and evolution. 2R, 3L, P, 320. (Identical with GENE 523)

524. Theoretical Population Genetics (3) I Mathematical theory of modern population genetics developed from first principles, with emphasis on evolutionary implications and the historical development of ideas. P, 320, MATH 223. (Identical with ANTH 524 and GENE 524)

525. Speciation (2) [Rpt.] II Mechanisms of evolution in the formation of species and populations. P, 320. (Identical with GENE 525)

531. Environmental Physiology (2) I 1993-94 Analysis and synthesis of recent studies of the physiological responses of animals to their environments. P, 568.

533. Human Genetics (3) I (Identical with GENE 533)

534. Population Interactions (4) [Rpt.] II 1994-95 Empirical and theoretical treatment of competition, exploitation, and mutualism within and between species, with emphasis on application of modern dynamics to ecological problems. Computer lab. 3R, 3L, P, 302, two semesters of calculus.

535. Evolution (3) I A balanced survey of the present-day concepts of the process and products of evolution, with emphasis on contrasting models and their consequences; recent techniques for the elucidation of phylogenetic pathways. P, 302, 320, MATH 125A, P or CR, 152b. (Identical with GENE 535)

536. Plant Ecology (4) II Dynamic processes giving rise to ecological patterns in plant populations and communities. 2R, 3L, P, some botany and general ecology.

538. Biogeography (3) II The role of historical events and ecological processes in determining the past and present geographic distribution of plants and animals. P, 182 or GEOS 225. (Identical with GEOS 538)

540R. Oceanography (2) I 1994-95 Introduction to the physical, chemical, geological, and biological dimensions of the oceans, with emphasis on their importance as biological environments.

540L. Oceanography Laboratory (2) I 1994-95 Field and lab. investigations of the Gulf of California, with emphasis on research techniques important to biological oceanography. Weekend field trips. P, 540R or CR.

541. Limnology (4) I (Identical with WFSC 541)

542. Marine Ecology (6) S A field introduction to basic concepts in marine ecology with emphasis on the behavior and ecology of invertebrates and fishes and the factors affecting the diversity and community structure of marine communities. The entire course is conducted at selected sites in the Gulf of California. Optional travel fee. Consult instructor before enrolling.
Economics (ECON)

McClelland Hall, Room 401
(602) 621-6224


Associate Professors John Z. Drabicki, Price V. Fishback, Donald G. Hecker, Ambrose C. McBrearty, Stanley S. Reynolds, Barbara N. Sands, Gerald J. Swanson, Ronald J. Vogel (Public Administration and Policy)

Assistant Professors Devajyoti Ghose, Shawn E. Kantor, Kenneth F. Kroner, Diego Moreno, James D. Ratliff, Leslie S. Stratton, John C. Wooders

The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees with a major in economics. The department also offers support work for the Master of Public Administration degree, the Master of Business Administration degree and Doctor of Philosophy degree with a major in management. For information concerning these degrees see Requirements for Master's Degree/Master of Public Administration and Master of Business Administration as well as the Business Administration headnotes elsewhere in this catalog.

Applicants must have completed an undergraduate major or minor in economics and must submit scores on the aptitude test of the Graduate Record Examination.

Degrees

Master of Arts: All students must complete the core program consisting of 501a, 502a, 508, 519, 520 and 522a, a nine-unit field of specialization; and a thesis. (A minimum of thirty total units is required.) The field of specialization may be in economics or a related area and must be approved by an advisor. The student will be given a comprehensive exam over the core program and field.

Doctor of Philosophy: All students must complete the core program consisting of 501a-501b-501c, 502a-502b, 506, 508, 519, 520, 522a-522b, eighteen units of 696-697 economics seminar and workshop courses, and a dissertation. A minimum of 66 hours is required.

500. Managerial Economics (3) I S Microeconomic theory and applications. P, MIS 400 or MATH 119 or 123. Advanced degree credit available for nonmajors only. Open only to students admitted to a BPA graduate program.

502a-502b. Macroeconomic Theory (3-3) II
502b: Advanced topics in macroeconomic analysis; macroeconomic dynamics. P, 502a, 519.

503. Development of Economic Theory (3) II
Development of economic thought from ancient times to the present. P, 501a.

504. Production Economics (3) I (Identical with AREC 504)

505. Comparative Economic Systems (3) II
Analysis of economic policy in market (capitalist) economies and of economic ideology and planning in command economies. Advanced degree credit available for nonmajors only. P, 361 or 500.


507. Studies in Microeconomics (3) II Studies in microeconomics, such as the economics of imperfect information and uncertainty, externalities and public goods, and imperfect competition. P, 361, MATH 125b.

508. Applied Economic Analysis (3) II Uses economic history to show how research methods in economics are used to analyze data collected through empirical observation. P, 501a, 520.

509. Economic Anthropology (3) II (Identical with ANTH 509)


511. Microeconomic Theory and Behavior (3) II Microeconomic theory with an emphasis on the use of experimental laboratory and field methods for testing the behavioral implications of the theory. P, 521.

512. Economic Policy in Developing Countries (3) II (Identical with AREC 512)

513. Consumption Economics and Price Analysis (3) II (Identical with AREC 513)

514. Cost-Benefit Analysis (3) II (Identical with AREC 514)

515. Operations Research in Applied Economics (3) I I (Identical with AREC 515)

516. Agricultural Development (3) I I (Identical with AREC 516)

518. Introduction to Econometrics (3) II Statistical methods in estimating and testing economic models; single and simultaneous equation estimation, identification, forecasting, and problems caused by violating classical regression model assumptions. Advanced degree credit available for nonmajors only. P, 339 or 376 or MKTG 552.

519. Mathematical Economics (3) I Introduction to the theory and methods of mathematical economics and its applications. Designed primarily for entering graduate students majoring in economics. P, CR, 520; consult with department before enrolling.

520. Theory of Quantitative Methods in Economics (3) I Introduction to the basic concepts of statistics and their application to the analysis of economic data. Designed primarily for entering graduate students majoring in economics. P, CR, 519; consult with department before enrolling.

521. Introduction to Mathematical Economics (3) II Comparative statics, stability, classical optimization, the Kuhn-Tucker theory, calculus of variations, linear algebra, and game theory, and the application of these techniques in economic analysis. P, six un-division units in economics; MATH 125b.


524. Topics in European, Chinese, or Japanese Economic History (3) II Explains the economic history and development of medieval, early modern and modern Europe; and the development and economic history of pre-modern and modern Japan and China. Advanced degree credit available for nonmajors only. P, 300 or 361 or 500.

525. Topics in the Economic History of the United States (3) II Examines the economic history and development of the United States, including roles of legal and cultural institutions, changes in output mix, government regulation, income distribution, monetary policy, and demographic factors. Advanced degree credit available for nonmajors only. P, 300 or 361 or 500.

530. Macroeconomic Aspects of Finance (3) II The effects of changing economic conditions upon a firm's operation, including capital decisions as well as production decisions. P, 500.


536. Innovation and Economic Growth (3) I (Identical with MKTG 536)


543. International Trade Theory (3) II S General equilibrium analysis of product and input markets of international trade, tariffs, commercial policy and growth, and the welfare aspects of each. Advanced degree credit available for nonmajors only. P, 361 or 500.


553. Business and Economic Forecasting (3) I Forecasting techniques used in business and government; assembly, interpretation and use of economic data; analysis of business conditions; examination of related environmental factors; construction of actual sales or revenue forecasts. P, 361 or 500; MKTG 552.

560. Industrial Organization (3) II S Structure, conduct, and performance of American industry; governmental institutions and policies affecting business. Advanced degree credit available for nonmajors only. P, 300 or 361 or 500, 339 or 376 or MKTG 552.

561. Economics of Regulated Industries (3) I II Economic analysis of the regulated sector of the American economy, including communications, transportation and energy industries, impact of existing and alternative public policies. Advanced degree credit available for nonmajors only. P, 300 or 361 or 500.


568. Environmental Scanning and Business Strategy (3) I II (Identical with MKTG 568)

570. Management and Evaluation of Information Systems (3) I II (Identical with MIS 570)

575. Economics of Natural Resource Policy (3) II (Identical with AREC 575)

576. Advanced Natural Resource Economics (3) I (Identical with AREC 576)

577. Advanced Topics in the Economics of Environmental Regulation (3) II (Identical with AREC 577)

589. Public Choice (3) II The study of voting theory, government expenditures, government structures, behavior of voters and bureaucracy. P, 361 or consent of instructor. (Identical with POL 589)

597. Workshop
a. Practical Applications of Economic Theory (3) I P, 501a, 502a, 521, 549.
b. Computational Methods in Laboratory Economics (1-3) [Rpt./3 units] I II P, MATH 125a-125b; consult department before enrolling.
c. Economic Issues for Teachers (3) S Consult instructor before enrolling.
d. Summer Institute on the American Economy (3) S Consult instructor before enrolling.
e. Economics Education Workshop (2) S Consult instructor before enrolling.
f. Economic Development for Educators (2) S Open to nonmajors only. Consult with department before enrolling.

*May be convoked with 400-level course.

596. Seminar
a. Experimental Economics I (3) II
b. Experimental Economics II (3) I
c. Economic Analysis of Organizations I (3) II
d. Economic Analysis of Organizations II (3)
e. Econometric Modeling I (3)
f. Econometric Modeling II (3)
g. Monetary Economics (3)
h. Labor Economics I (3)
i. Labor Economics II (3)
j. Public Policy Analysis I (3)
k. Public Policy Analysis II (3)
l. International Economics I (3)
m. International Economics II (3)
n. Advanced Macroeconomic Theory I (3)
o. Advanced Macroeconomic Theory II (3)
p. Industrial Organization and Regulation I (3)
q. Industrial Organization and Regulation II (3)
r. Advanced Microeconomic Theory I (3)
s. Advanced Microeconomic Theory II (3)
t. Mathematical Economics I (3)
u. Game Theory I (3)
v. Public Choice I (3) (Identical with POL 696w)
w. Public Choice II (3) (Identical with POL 696w)
x. Economic History I (3)
y. Economic History II (3)

697. Workshop
a. Experimental Economics (3) P, 696a, 696b.
b. Economic Analysis of Organizations (3) P, 696c, 696d.
d. Labor Economics (3) P, 696g, 696h.
e. Public Policy Analysis (3) P, 696i, 696j.
g. Advanced Macroeconomic Theory (3) P, 696m, 696n.
i. Advanced Microeconomic Theory (3) P, 696r, 696s.
j. Economic History (3) P, 696t, 696u.

language, reading and
culture . . . M.A./Ed.S./Ed.D./Ph.D.
reading . . . . . . . . . . . . . . . . M.Ed.
Department of Special Education and
Rehabilitation
special education . . . . . . . . . M.Ed.
special education and
rehabilitation M.A./Ed.S./Ed.D./Ph.D.

Department of Teaching and Teacher
Education
educational media . . . . M.Ed./Ed.S.
elementary education . . M.T.
secondary education . . . . M.T.
teaching and teacher
education . . . . M.A./Ed.D./Ph.D.
environmental education strand
is available . . . . . . . . M.A.

For further information, see individual
department listing.

Education (EDUC)
The College of Education offers certain
courses that are not directly affiliated
with any of the academic departments in
the college. In many cases, these courses
are college-wide requirements for degree
programs.

500. Disciplined Inquiry in Education (3) I
S Introduction to research methods in education:
analysis of research; writing of research
reviews; applying research results in educational
settings.

501. Foundations of Education (3) I
S Schools and social institutions; political
and social influences on education; nature of the
education profession; reform and implementation in education.

502. Variations in Learners (3) I S
Nature and extent of differences among learners,
both among and within groups; causes and
factors relating to variations in learners; implications for educational placement,
curricular planning and program development.

600. Quantitative/Inferential Methods in
Education (4) I S Statistical knowledge for use
in describing educational research data and
relationships between sets of data; statistical
relationships among various forms of educational

601. Qualitative Methods in Education (3) I
S Introduction to theory and methods of conducting research through extended participant
observation in school or community settings; field work, ethnography, case study.
Qualitative methods. P, 500.

602. Research Design and Techniques in
Education (3) I S In-depth explorations of various research paradigms in educational inquiry
and their research designs; critical analysis of the structure and logic of various designs and techniques; preparation of research proposals. P, 600, 601.

604. Leadership for Educational Change (3) I
S Investigations of the characteristics of leadership as they apply to changing basic educational organizational structures and processes.

See:
Educational Administration and Higher Education
Educational Psychology
Language, Reading and Culture
Special Education and Rehabilitation
Teaching and Teacher Education

Educational Administration and Higher Education
(EDA/HED)
Education Building, Room 635
(602) 621-3327
Professors Larry L. Leslie, Department Head, Waldo K. Anderson, (Emeritus),
Henry E. Butler, Jr. (Emeritus), Robert T. Grant (Emeritus), Fred Harcleroad
(Emeritus), Lawrence O. Nelson, F. Robert Paulsen (Emeritus), Macario
Saldate, IV, T. Frank Saunders, Sheila Slaughter, Marsden B. Stokes (Emeritus),
Dudley B. Woodard, Jr.
Associate Professors Sharon C. Conley,
Marcello Medina, Jr., Stanley Pogrow,
Gary Rhoades
Assistant Professor Paul E. Heckman
The department offers programs leading to the Master of Arts degree with a major in higher education. The Education Specialist degree is offered with a major in educational administration. The Doctor of Education degree is offered with a major in educational administration. The Doctor of Philosophy degree is offered with a major in higher education. (The Master of Arts and Doctor of Philosophy degrees in Foundations of Education are currently under review.)

Concentrations are available within graduate majors offered in the department. The major in higher education is offered through the Center for the Study of Higher Education, with concentrations in academic administration, student personnel services administration, finance and business affairs administration, community college administration, curriculum and instruction, higher education policy making, and institutional research and planning.

The department also offers certification in educational administration. Students seeking institutional recommendation for Arizona administrative certification should major in educational administration. In the Center for the Study of Higher Education, master's degree programs may be designed to meet the requirements for the Arizona Community College Teaching Certification (Type A1a) or for entry-level administrative service in institutions of higher education.

An undergraduate grade-point average of at least 3.00 is required for admission to full standing in a graduate degree program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. Standardized test scores also are required (e.g., GRE, Millers Analogies). Beyond these minimal requirements, applicants must also meet the specific requirements for all majors offered in the department.

**Educational Administration (EDA)**

597. Workshop
   a. *Trends in Educational Administration (3) [Rpt./12 units] I I S.
   b. School Evaluation/Accreditation: Problems and Procedures (3) I I S.
   *May be con veneed with 400-level course.

600. Administration and the Educational Environment (3) I I S Introduction to educational administration; overview of administration within school contexts and larger societal environment; organizational and leadership theories.

661. Administration of Bilingual Education Programs (3) I S Dynamics of the administration of educational programs for the bilingual learner including socio-political realities, mandated federal and state funded educational programs, and effective community participation.

662. Educational Law: Policy and Practice (3) I S Evolution of modern educational law and the effects of law on educational policy formation and administrative practice.

663. Computer Applications in School Administration (3) I Techniques for using computers to make school administration more efficient and effective in using computers to enhance the management of information. P. 660 or CR.

664. Personnel Administration in Education (3) I Composition of school staffs and the functions of various personnel; patterns and practices in school personnel management; issues, trends, and prospects in personnel management. P. 660.

665. Supervision of the Instructional Program (3) I S Purposes of instructional supervision; organization, techniques and skills for supervisory competency. P. 660.

666. Educational Governance and Collective Bargaining (3) I Theory and practice of collective bargaining; history of negotiations in the educational sector; impact of statutes and governing authority. P. 660, 662 or CR.

667. Managing Curriculum Change (3) I Techniques for administrators to use in analyzing the quality of the curriculum in schools as well as the appropriateness of instructional techniques used to support the curriculum. P. 660 or CR.

671. School Finance (3) I Historical background of the financing of education in the United States; economics and principles; sources and distribution of funds for education; budgeting, accounting, and reports. P. 660, 661 or CR.

672. School Business Management (3) I The general management of school business; administration and accounting of school funds; administration of equipment and supplies; other business operations. P. 660 or CR.

674. Law and Administrative Practice (3) I Routine and continuous effects of law in public schools; tort liabilities, collective bargaining, influence of federal and state regulations, teacher dismissal; Arizona statutory and case law emphasized. P. 660, 661, 662.

675. Theory and Behavior in School Organizations (3) I I S Perspectives on the nature of the individual in the school organization; nature of schools as organizations; development of individual-organizational relationships. P. 660.

681. The Principalship (3) I I S Functions and activities of building-level administrators, with emphasis on instruction, staff development, student services evaluation, and operational services. P. 693a and 15 units of educational administration, CR 693b.

682. The Superintendent (3) I I S Functions and responsibilities of the chief school executive and central office staff, with emphasis on external and internal system relationships in policy formation and decision-making. P. 693a, 693b or CR.

693. Internship
   a. Educational Administration (2-3) [Rpt./4 units] II I S P. 660, 661, 662 or CR.
   b. Advanced Educational Administration (3-4) [Rpt./8 units] I I I I P. 693a and 15 units of educational administration, CR. 681 or 682.

695. Colloquium
   a. Issues in Educational Administration (1-3) [Rpt./12 units] I I I I

696. Seminar
   a. Topics in Educational Administration (1-3) [Rpt./12 units] I I I I

697. Workshop
   a. Problems in Educational Administration (1-3) [Rpt./12 units] I I I I

**Higher Education (HED)**

*Education Building, Room 327 (602) 621-7951*

561. The Community College (3) I The scope, objectives, and educational functions of the community college; patterns of community college programs.

601. Higher Education in the United States (3) I The scope of higher education in the United States; brief survey of historical developments and philosophic bases, public policy issues at the state and federal level; types of institutions and their purposes; characteristics of faculty, students and curricula.

608. The College Student (3) I History and characteristics of the college student; interactions with campus environmental influences; developmental and normative trends; major research findings.

609. Organization and Administration in Higher Education (3) I Organizational theory, structures, systems, and administrative procedures in varied higher education institutions; patterns of governance and policy development.

617. Student Personnel Services in Higher Education (3) I Student personnel services, philosophy, history, administrative procedures, representative programs, current trends.

622. Teaching in Higher Education (3) I Planning, organizing, presenting and evaluating learning experiences for mature students.

641. Institutional Research and Planning (3) I Development of institutional research programs for short-term and long-term planning; input and output measures.

650. Higher Education Finance (3) I Historical patterns of financing private and public higher education; current sources and types of financial support; alternative methods of financing; social benefits and consumer theories.

651. Higher Education Business Management (3) I Budget planning and execution; systems of resource allocation, personnel management, physical plant planning and construction; information systems and use in management.

661. Higher Education and the Law (3) I Critical court decisions, past and present, af-
Aspects of growth and development which relate to adolescent years, emphasis on the importance of early adolescence (ages 10-14 years old). Also, implications of theory into practice regarding early adolescents and schooling.

Major developmental issues within the adolescent years, emphasis on current research findings. (Identical with FS 503)

Learning Theory in Education (3) II Major theories of learning and motivation, emphasis on relationships between theory and practice in the schools.

Classroom Application of Behavior Modification Techniques (3) II Application of behavior principles and techniques to promote learning and social development of school-related behavior. 2R, 3L. P. 510 or CR.

Socio-Cultural Context of Human Development (3) II (Identical with FS 523)

School Psychology (3) II Roles of the school psychologist; implementing programs in the public schools; legal and ethical issues in school psychology. 2R, 3L.

Statistical Methods in Education (3-4) II Descriptive, correlational, and inferential procedures for presenting and analyzing school and research data. For students in all fields. 3R, 1L.

Design of Questionnaires and Scales (3) II Emphasis on theoretical and methodological issues related to the development of survey and rating scales, sampling procedures, and response bias.

Educational Tests and Measurements (3) II Theoretical and practical application of psychometric techniques to test construction, analysis, and interpretation of test results. P. 541.

Testing of Minorities (3) II Current theoretical, social, and practical issues in the use of norm-referenced tests with individuals from minority cultures.

May be taken with 400-level course.

Theories of Human Development (3) History and analysis of psychological theories of human development and a comprehensive overview of major theoretical systems. P. 500 or 501.

Psychological Theory in Educational Practice (3) II Major theories of psychological thought; strategies for utilizing such theories in educationally relevant research. P. 510.

Cognitive Development (3-3) II Cognitive theory and research as they bear upon developmental and educational processes. P. 500 or 501.


Behavioral Consultation in Educational Settings (3) II Principles and techniques of conducting behavioral consultation in educational settings to promote learning and development of children and youth. 2R, 3L. P. 517.

Advanced Statistical Methods in Education (3) II Inferential procedures for analyzing educational data; includes nonparametric methods and introduction to multivariate and causal procedures. P. 541.

Multidimensional Methods in Educational Research (3) II Provides an understanding of facility with research application of multivariate correlational techniques, such as multiple regression, discriminant function, canonical correlation, and factor analysis. P. 640.

Factor Analytic Techniques in Education (3) II Principles and techniques of factor analytic procedures for analyzing data in educational research. P. 558 or 640.

Theory of Measurement (3) II Advanced topics in the theoretical and practical issues in psychometrics. P. 558 or 640.

Theories of Intellectual Assessment (3) II Various theories and models of human ability and their implications for intellectual assessment. P. 558 or CR.

Field Experience in Intellectual Assessment in the Schools (3-3) Supervised field experience in the administration, scoring and interpretation of various intellectual assessment devices. 674a: Wechsler Adult Intelligence Scale. 674b: Intellectual assessment techniques. 1R. 3L. Open to majors and minors only. Credit allowed for 674a or 674b, but not for both. P. 673 or CR.

Individual Assessment Techniques in the Schools (3) II Techniques for assessing personality and social behavior; practice in implementing programs derived from assessment techniques. 2R, 3L. Open to majors and minors only. P. 673, 674b.

Psychoeducational Assessment in the Schools (3) I Psychoeducational assessment techniques; practice in prescribing remedial programs. 2R, 3L. Open to majors and minors only. P. 673, 674b.

Educational Program Evaluation Principles and Techniques (1-3) [Rpt./12 units] I II S

Educational Research /Evaluation (1-3) [Rpt./12 units] I II S

College Teaching (1-3) [Rpt./12 units] I II S

Internship a. Research/Evaluation (1-3) [Rpt./12 units] I II S
b. School Psychology (1-3) [Rpt./12 units] I II S
c. College Teaching (1-3) [Rpt./12 units] I II S

Practicum b. Issues in Educational Psychology (1-3) [Rpt./12 units] I II S

Colloquium b. Issues in Educational Psychology (1-3) [Rpt./12 units] I II S

Seminar b. Issues in Educational Psychology (1-3) [Rpt./12 units] I II S
requires at least 15 units in the major field (no more than 9 of these may be jointly convened 400/500-level courses), 6 units in the minor field, and 6 units of thesis. The nonthesis option requires at least 21 units in the major field (no more than 9 of these may be jointly convened 400/500-level courses), and 6 units in the minor field. Candidates must pass a final oral examination. A nonmajors program is available for qualified students who do not hold B.S. in Electrical Engineering or B.S. in Computer Engineering degrees.

The Ph.D. program must contain a minimum of 54 units of course work (including the Master of Science degree) and 18 units of dissertation study. A minimum of 18 units in the major field and 6 to 12 units in the minor field must be completed at the University of Arizona. To satisfy the residence requirement, the student must spend a minimum of two regular semesters of full-time study on campus. Students must pass a qualifying examination, which is taken during the first semester of residence beyond the master's degree, and are admitted to candidacy after passing a written and oral preliminary examination near the end of the study program. The final examination is a defense of the dissertation. There is no foreign language requirement.

Applicants are required to submit Graduate Record Examination (GRE) General Test scores and a statement of purpose directly to the department. All students whose native language is not English must submit TOEFL scores directly to the Graduate College. Applications to the Ph.D. program must also contain three letters of recommendation from M.S. professors.

Additional details concerning requirements for the master's or doctoral program may be obtained on request from the department graduate studies office (602) 621-6195.

501. Linear Systems Theory (3) I Mathematical descriptions of linear systems, state-variable models, analysis methods-stability, controllability and observability, state feedback techniques, design of feedback controllers and observers.


515.* Instrumentation and Measurement (3) I II Basic concepts of instrumentation and measurement; principles of transducers, operational amplifiers and instrument systems, with emphasis on biomedical applications; lab, experiments with transducers, amplifiers, computers, and medical equipment. 2R, 3L.


524. Active RC Filters (3) I Modern techniques for realizing active RC filters using passive elements and operational amplifiers gain blocks; determination of sensitivity; effects of gain-bandwidth.

525.* Image Science and Engineering (3) II Properties of optical images and image forming systems; acquisition and manipulation of digital images; two-dimensional Fourier representation; image quality criteria; introduction to image processing. P, 340.

526.* Modern Filtering and Signal-Processing Techniques (3) II Operational amplifier circuits, nonideal amplifier limitations, active RC filter design, nonlinear wave shaping, switching; A/D and D/A components; interfacing. P, 320.

527. Holography (3) II 1994-95 (Identification with OPTI 527)


530.* Optical Communication Systems (3) II Optics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications. P, SIE 230, ECE 340, 352, 381; CR, 431.

531. Image Processing Laboratory for Remote Sensing (3) I Techniques and applications of digital image processing in remote sensing, multispectral image enhancement and analysis, classification, feature extraction for cartography, rule-based systems for mapping from imagery. 3R, 1L. (Identical with OPTI 531)


534. Advanced Topics in Electronic Materials (3) (Rpt./2) 1994-95 (Identical with MSE 534)

535.* Noise in Communications Systems (3) I Principles of communication in the pres-
ence of noise; discussion of basic statistical techniques, noise sources, SNR, and error rates. Credit is allowed for this course or for 538 but not for both. P, 431, SIE 230.

536.* Introduction to Coding Techniques (3) I Error-correcting codes used in modern digital communications systems, with emphasis on hardware implementations and performance on real channels. P, 274 and SIE 230.

537. Digital Transmission and Telephony (3) Spectrum control, demultiplexing, and multiplexing in digital transmission systems. Topics include line coding, scrambling, spread spectrum, time-division multiplexing, frequency division multiplexing, timing recovery, frame synchronization, jitter, and echo cancellation. P, SIE 230 and ECE 431.

538. Digital Communications Systems (3) II Digital modulation techniques for the Gaussian white noise channel, emphasizing optimal demodulation methods analysis of error rates, and signaling techniques over finite bandwidth channels. Credit is allowed for this course or for 535 but not for both. P, 503.

539. Algebraic Coding Theory (3) II 1993-94 (Identical with MATH 539)

540. Advanced Microelectronic Processing (3) I Theory of diffusion, oxidation, deposition and processing, etc. and process integration. P, 485.


546.* Photovoltaic Systems Engineering (3) I (Identical with NEE 546)

547.* Direct Energy Conversion (3) II (Identical with NEE 547)


549. Analog Integrated Circuits (3) I Non-switching aspects of analog integrated circuits using bipolar or CMOS technologies. Basing, DC behavior, small signal behavior. Emphasis on use of physical reasoning, identification of circuit functions, and use of suitable approximations to facilitate understanding and analysis.


551. Solid-State Devices (3) II Basic semiconductor physics and materials. PN junctions, metal semiconductor junctions/contacts, BJTs and MOSFETs, device operation, terminal behavior and frequency response, device models. P, 352, 451.

552. Electronic Packaging Principles (3) II 1993-94 Introduction to problems encountered at all levels of packaging: thermal, mechanical, electrical, reliability, materials and system integration. Future trends in packaging. (Identical with A ME 554 and MSE 554)

553. VLSI Chip Engineering (3) I Layout methods and tools for MOSFET and bipolar ICS, statistical circuit design techniques, circuit models for SPICE simulation, ESD and latch-up protection, electrical protection and layout design using modern CAD systems. P, 458.

554.* Optoelectronics (3) I Properties and applications of optoelectronic devices and systems. Topics include radiation sources, detectors, and detector circuits, fiber optics, and electro-optical components. P, 352, 381.

555. Integrated Circuit Laboratory (3) Experiments in diffusion, oxidation, processing, etc. Fabrication of an integrated circuit. P, 458, 540, or equivalent (Identical with MSE 457)

556. Vacuum System Engineering (3) II 1993-94 Rarefied gas dynamics, pumping, gauging and systems as they apply to microelectronic device and thin-film fabrication. Materials and techniques for ultraclean and ultrahigh vacuum processing. P, 557b or consult department before enrolling.

557.* Laser Principles and Devices (3) I Introduction to the characteristics of laser radiation including Gaussian beam propagation, ABCD Law, beam guiding, and resonators. Material requirements for stimulated emission, light amplification and threshold. Also covered: basic types of laser systems with an emphasis on semiconductor lasers. P, 352, 381; CR, 482.

558. Aerosol Science and Engineering (3) I 1993-94 (Identical with CH E 560)


560. Plasma Processing (3) II Practical methodology of plasma etching, sputtering, and plasma enhanced CVD. Plasma physics and plasma chemistry. RF and DC discharges. P, 557 or consult department before enrolling.

561. Engineering Application of Graph Theory (3) I Emphasis on qualitative aspects and applications of graph theory. Terminology, algorithms, and complexity analysis will be included. Application areas will include, but are not limited to, communication networks, VLSI routing and layout, analog circuits, and mapping of sequential and parallel algorithms onto computer architectures.

562.* Operating System Concepts (3) I Fundamental issues in the design, implementation and evaluation of distributed computer systems. Focus on understanding, using, and designing upper-level network protocols and interfaces. Topics include OSI, TCP/IP and SNA protocols, and the TLI and socket interfaces. P, 564, 578.

563. Microelectronics Packaging Materials (3) II (Identical with MSE 565)

564. Computer Network Design (3) II Fundamental issues in the design, implementation and evaluation of distributed computer programs. Focus on understanding, using, and designing upper-level network protocols and interfaces. Topics include SOL, TCP/IP and SNA protocols, and the TLI and socket interfaces. P, 564, 578.


571a-571b. Digital Systems Design (3-3) 571a: Computer organization and architecture; control unit design, microprogramming, input/output. 571b: Advanced I/O, bus arbitration, interface design, fault tolerance, associative cache, and virtual memory, RISC architectures. (Identical with C SC 571a-571b)


573.* Software Engineering Concepts (3) I In-depth consideration of each of the phases of the software project life cycle. Object-oriented design and programming. Includes a large-scale software development project involving groups of students. 2R, 2L, P, 371.
574a-574b. *Computer-Aided Logic Design (3-3) I II 574a: Tabular minimization of single and multiple output Boolean functions, NMOS and CMOS realizations, synthesis of sequential circuits, RTL description, laboratory exercises. P. 271a. 574b: Standard cell layout, gate and switch level simulation, level mode sequential circuits. VLSI testing, CAD tools, laboratory projects. (Identical with CS 574a-574b)

575. Object-Oriented Simulation/Discrete Event Models (3) II Introduction to object-oriented simulation methodology and its implementation on multi-processors. Modular hierarchies and discrete event model design and mapping onto distributed simulator architectures. Prior course in simulation recommended.

576. Knowledge-Based System Design (3) II Provides a framework for systematic design of systems and for constructing computer-aided environments to support engineering design activities. Characterization of design methodologies; introduction to knowledge-based design; system design and simulation modeling; knowledge-based model of design, representing designs and design knowledge, design model synthesis, concepts for design evaluation, learning and creativity in design systems. A large-scale term project is central to the course. P. 479, 473.


579. *Principles of Artificial Intelligence (3) I Provides an introduction to problem-solving and techniques of artificial intelligence (AI). Problem solving; basic problem solving methods and techniques; search and game strategies, knowledge representation using predicate logic; structured representations of knowledge; semantic nets, system entity structures, frames and scripts; planning, learning, expert systems; implementing AI systems. 1.5ES, 1.5ED. P. 571, 473.

581a-581b. Electromagnetic Field Theory (3-3) 581a: II-Time-harmonic fields; fundamental theorems and concepts; rectangular and circular waveguides and resonators; apertures in ground planes, cylinders, and wedges; scattering by cylinders and wedges. P. 502 or MATH 422b; 482 or PHYS 415b. 581b: I Spherical geometries: interface problems; perturbational techniques; integral equations; asymptotic techniques; introduction to transmission fields.

583. Remote Sensing Instrumentation and Techniques (3) II Development of instrumentation, measurement and signal processing techniques required for electromagnetic remote sensing applications with emphasis on atmospheric remote sensing. P. 482. (Identical with ATMO 583)

584. Advanced Antenna Theory and Design (3) II 1994-95 Electromagnetic radiation and diffraction; dipoles, slots, open wave guides, and horns; apertures, reflectors, and arrays; mechanical and electronic scanning; applications to practical radar and communications problems. P. 581a.

585. *Radio Waves (3) II 1994-95 Geometrical ray tracing, diffraction and scattering, ground waves propagation, magneto-ion theory, random media effects, topographic influences, satellite communications, and fiber optic transmission. P. 482.

587. *Fiber Optics Laboratory (3) II (Identical with OPTI 587)

589. Atmospheric Electricity (3) II 1993-94 (Identical with ATM 589)

597. Test Generation for Automata (3) I Fault modeling, Boolean differences, D-algorithm, branch and bound searching, partitioning and state assignment for sequential circuits, iterative networks, fault simulation, built-in self-test. P. 574a. (Identical with CS 574d)


587. Integrated Telecommunication Networks (3) I Analysis and design of integrated voice, data, and image networks for integrated telecommunication applications. Protocols for LANs, ISDNs, WANs, MANs and interoperable networks. ISO-based network software design for applications. P. 566, 673.

594. Advanced Artificial Intelligence (3) I II Expert system design, reasoning under uncertainty, advanced planning methods in AI, care based reasoning, machine learning, logical foundations of intelligent systems. P. 579.


596. Seminar
Engineering and Mines (ENGR)

Geology Building, Room 134
(602) 621-6032

Within the colleges of Engineering and Mines, and Agriculture, programs are offered leading to the Master of Science (M.S.) and the Doctor of Philosophy (Ph.D.) degrees as indicated in the following list of departments and majors:

- Aerospace and Mechanical Engineering
  - aerospace engineering  ... M.S./Ph.D.
  - mechanical engineering  ... M.S./Ph.D.
- Agricultural and Biosystems Engineering
  - agricultural and biosystems engineering  ... M.S./Ph.D.
- Chemical Engineering
  - chemical engineering  ... M.S./Ph.D.
- Civil Engineering and Engineering Mechanics
  - civil engineering  ... M.S./Ph.D.
  - engineering mechanics  ... M.S./Ph.D.
- Electrical and Computer Engineering
  - electrical engineering  ... M.S./Ph.D.
- Hydrology and Water Resources
  - hydrology  ... M.S./Ph.D.
  - water resources administration  ... M.S./Ph.D.
- Materials Science and Engineering
  - materials science and engineering  ... M.S./Ph.D.
- Mining and Geological Engineering
  - mining engineering  ... M.S./Ph.D.
  - geological engineering  ... M.S./Ph.D.
  - geophysical engineering  ... M.S./Ph.D.
- Nuclear and Energy Engineering
  - nuclear engineering  ... M.S./Ph.D.
- Systems and Industrial Engineering
  - systems engineering  ... M.S.
  - industrial engineering  ... M.S.
  - reliability and quality engineering  ... M.S.
  - systems and industrial engineering  ... Ph.D.

Qualified students working toward an advanced degree in various engineering programs may select certain options which are interdisciplinary or interdepartmental in nature. The programs in which these options are available and descriptions of the option follow:

- Biomedical Engineering: This option is available in the departments of Aerospace and Mechanical Engineering, Chemical Engineering, Electrical and Computer Engineering, Nuclear and Energy Engineering, and Systems and Industrial Engineering. Biomedical engineering is a multidiscipline in which physical scientists and engineers interact with life scientists and physicians to solve problems ranging from basic investigations to applications in clinics and related health service facilities. The work is coordinated by the Committee on Biomedical Engineering.

  **Clinical Engineering:** This option is available in the departments of Electrical and Computer Engineering and Aerospace and Mechanical Engineering. Clinical engineering can be defined as the application of engineering methods and technologies to the problems and needs of medicine and health care delivery. Clinical engineering implies bedside or patient-related engineering and involves the use of the engineer's background and skills as a part of the total health care team. The option includes specific elective course work, laboratories, a thesis project, and a nine- to twelve-month clinical engineering internship in a hospital.

  **Energy Systems Engineering:** This option is available in the departments of Aerospace and Mechanical Engineering, Chemical Engineering, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, and Nuclear and Energy Engineering. The program is designed to encourage engineering study and research efforts directed toward society's energy needs. The scope of interest includes energy sources (fossil, geothermal, hydro, nuclear, and solar); systems to convert and transfer energy and power; efficient energy utilization; and environmental controls. Applied research and industrial interaction are stressed. The program is coordinated by a committee representing the departments in which the option is available.

  **501. Planning for Discovery: Problem Selection and Proposal Preparation (3) II (Identical with MSE 501)**
  **502. Research Proposal Preparation (3) I (Identical with MSE 502)**
  **504. Law for Engineers/Scientists (3) II (Identical with CH E 554) May be convened with 454.**

**Engineering Mechanics**

(See Civil Engineering and Engineering Mechanics)

**English (ENGL)**

Modern Languages Building, Room 445
(602) 621-1836


Assistant Professors Laura Berry, Meg Lota Brown, Daniel Cooper-Alarcon, Theresa Enos, Elizabeth Evans, Naomi Miller, Thomas Miller, Alice M. Senob (Emerita), Victoria Stein, Michelle Taigue, Susan White

The department offers programs leading to the Master of Arts degree with a major in English or in English as a second language, the Master of Fine Arts degree with a major in creative writing, and the Doctor of Philosophy degree with a major in English or a major in rhetoric, composition and the teaching of English.

**Degrees**

**Master of Arts (Major in English):** To be admissible, applicants must have completed the equivalent of the undergraduate major in English with a grade-point average of at least 3.50 in courses in English. Applicants must submit scores on the aptitude and advanced literature in English tests of the Graduate Record Examination and a short sample of their scholarly or critical writing. Applicants must also arrange to have the department receive three letters of recommendation. These materials should be addressed to the Director of Graduate Study of the Department of English.

**Master of Arts (Major in English):** To be admissible, applicants must have completed the equivalent of the undergraduate major in English with a grade-point average of at least 3.50 in courses in English. Applicants must submit scores on the aptitude and advanced literature in English tests of the Graduate Record Examination and a short sample of their scholarly or critical writing. Applicants must also arrange to have the department receive three letters of recommendation. These materials should be addressed to the Director of Graduate Study of the Department of English.
any undergraduate major may apply. Scores from the Graduate Record Examination must be submitted along with evidence of completion of two years of study of a foreign language or equivalent proficiency. International students must provide TOEFL scores of at least 550. Proof of some prior teaching or tutoring experience must also accompany the application.

Master of Fine Arts: For information concerning this degree see Requirements for Master's Degrees/Master of Fine Arts elsewhere in this catalog.

Doctor of Philosophy: The admission requirements for this degree program are the same as those set forth for the Master of Arts with a major in English, above. At least 30 units of 500-level work (beyond the requirements for the Master of Arts degree) must be completed in addition to the dissertation. All students must pass a qualifying examination. All students for the Ph.D. degree are required to pass the Ph.D. preliminary examination and write a dissertation acceptable to the Department of English.

Contact the Director of Graduate Study of the Department of English for further information.

501. Writing Project in Creative Nonfiction Writing (1-4) [Rpt./24 units] I II For M.F.A. candidates working on personal essays, or consult department before enrolling.

505. History of the English Language (3) I II The evolution of English sounds, inflections, and vocabulary from earliest times to the present, with attention to historical conditions. (Identical with GER 505)

506. Modern English Grammar (3) I II S Introduction to the nature of grammar and approaches to the description of English grammar, emphasizing Chomsky's transformational generative model. Focus is on grammatical structure, but scope includes phonology and social/historical factors which influence the form and use of English in various contexts. Includes practice in phonemic transcription and sentence diagramming. P, 405.

508. English as a Second Language in Bilingual Education (3) I II S Methodology for the teaching of English as a component of bilingual education; grammar, phonology, and syntax as they apply to the teaching of language.


511. Teaching of Literature (3) I II Theory and practice of teaching literature, with intensive study of genres and works commonly taught in secondary schools. P, nine units of literature.


513. Poetry in Forms (3) [Rpt.] I II Explores prosody through discussing and writing of forms and types, research paper. P, 309.

514. Advanced Scientific Writing (3) I II Preparation of professional literature for publication.

515a-515b. History of Criticism and Theory (3-3) 515a: Plato through the 19th century. 515b: Modern criticism and theory.

516. Theories of Linguistic Structure (3) I II In-depth examination of at least two recent theoretical models of linguistic structure, including Chomsky's, with attention to English and cross-linguistic differences. P, 506 or an introductory linguistics course.

520. History of the German Language (3) II 1935-94 (Identical with GER 520)

521. American English (3) II History of the development of American English from the colonial period to the present. Topics include regional and social varieties, language contact, and slang. Geographic atlas, social survey, and lexicographic research methods are utilized. P, 405 or introduction to linguistics.

524. Studies in Southwest Literature (3) I II (Identical with AINS 524)

525. Beowulf (3) I II (Identical with GER 525)

526. Advanced Studies in Chaucer (3) II

527a-527b. Studies in Medieval Language and Literature (3-3) 527a: Old English. (Identical with GER 527a). 527b: Middle English.

529. Chinese-American Literature 1960 -Present (3) I II (Identical with CHN 529)

531. Advanced Studies in Shakespeare (3) I

533. Studies in the Renaissance (3) [Rpt./1] I

534. Advanced Studies in Milton (3) I

536. Japanese Sociolinguistics (3) [Rpt./1] I (Identical with JPN 536)

541. Studies in the Restoration and Eighteenth Century (4) [Rpt./1] II 3R, 1L.

545. Introduction to TESL: An Overview (2) I The development of English as a second language with emphasis on current trends, the influence of linguistic theory, and the international role of English.

548. Theory and Practice of Writing (3) 1993-94 (Identical with FREN 548)

549a-549b. Folklore (3-3) 549a: Forms of verbal folklore; 549b: Non-verbal folklore and material culture (Identical with AINS 549a-549b; ANTH 549a-549b and CLCS 549a-549b)

554. Contemporary Feminist Theories (3) I (Identical with W S 554)


561. History of Children's Literature (3) II (Identical with LI S 561)


577. American Indian Literature (3) I II (Identical with AINS 577)

585. Linguistics and Computer-Assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with GER 585)

587. Testing and Evaluation in Foreign/Second Language Programs (3) (Identical with GER 587)

595. Colloquium

a. Professional Studies (1-3) I II [Rpt./4] Designed for teaching assistants in English. May also be used, at discretion of graduate program directors in English, for other professional training.

596. Seminar

a. Medieval Literature (3) [Rpt./4] I II
b. Renaissance Literature (3) [Rpt./4] I II
c. Restoration and Eighteenth-Century Literature (3) [Rpt./4] I II
d. Nineteenth-Century British Literature (3) [Rpt./4] I II

597. Workshop

a. Southern Arizona Writing Project (3-9) [Rpt./12 units] I II S (Identical with LRC 597a), which is home.

b. The Teaching of English (3) I II S [Rpt./3] (Identical with LRC 5970)

c. Research and Composition (3) II

597a, which is home)

*May be convened with 400-level course.

604. Writing Project in Fiction (1-6) [Rpt./24 units] I II For M.F.A. candidates working toward book-length writing project in fiction.

609. Writing Project in Poetry (1-6) [Rpt./24 units] I II For M.F.A. candidates working toward book-length writing project in poetry.

612. Grammatical Analysis (3) I English grammatical analysis in relation to the acquisition of English as a second language. B 406/506, or introductory linguistics course. (Identical with LRC 612)

613. Second Language Acquisition in Formal Contexts (3) I Foundations, theory, and meth-
Entomology (ENTO)

Forbes Building, Room 410 (602) 621-1151

Professors Elizabeth A. Bernays, Head, William S. Bowers, Reginald F. Chapman, Eddie W. Cupp (Veterinary Science), Renee Feyereisen, Henry H. Hagenhorn, John G. Hildebrand, Roger T. Huber, Leon Moore (Emeritus), Jose M.C. Ribeiro, Donald M. Tuttle (Emeritus), George W. Ware (Emeritus), Theo F. Watson

Associate Professors Nancy A. Moran (Ecology and Evolutionary Biology), Robert L. Smith

Assistant Professors David R. Maddison, Martin F. Taylor, Diana E. Wheeler

Associate Research Scientist David Byrne

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees in entomology. Faculty interests include behavioral ecology, plant-insect interactions, chemical ecology, biochemistry and physiology of vectors, and veterinary entomology. Biological control, insect migrations, integrated pest management, toxicology, and behavior, biochemistry, and evolution of resistance, physiology, social insects, evolutionary biology, and systematics. Research opportunities with insects also exist in the departments of Biochemistry, and Ecology and Evolutionary Biology, and through the Committee on Neuroscience. The Center for Insect Science provides opportunities for collaborative research at the University of Arizona, Arizona State University, and several USDA facilities in the state. Facilities for field studies include university agricultural centers in Maricopa and Yuma and a farm with an entomology lab three miles from campus. Natural habitats can be studied on University land in the Sonoran Desert and in the rangelands and canyons of the Santa Rita Mountains. Several excellent field centers are available in the diverse biomes of southern Arizona.

Admission requirements include the completion of an undergraduate major in the biological sciences. The graduate program should include coursework in biology, organic chemistry, mathematics, and theoretical and experimental ecology, molecular, cellular and molecular aspects of biology. Applicants must submit scores on the general and subject tests of the Graduate Record Examination and three letters of recommendation from persons in a position to assess the applicant's potential as a graduate student. Inquiries concerning financial aid should be addressed to the department.

Graduate study programs are individually planned and approved by the student's committee. Candidates for the Master's degree in entomology will be required to take ENTO 201, 2 units of seminar and two courses selected from ENTO 504, 507, 511, 516, and 544. A thesis is required. Candidates for the Master's degree with a concentration in applied entomology can specialize in agricultural entomology, urban entomology, or medical and veterinary entomology. Course requirements are ENTO 508, 516, 544 and 3 courses selected from the area of specialization. A thesis is required. The doctoral program requires ENTO 201, 4 units of seminar, and three courses selected from ENTO 504, 507, 511, 516 and 544, plus 6 credits from upper division courses offered by the Department of Entomology.

502. * Agriculture and the Environment (3) I (Identical with A ED 502) Huber

503R. * Biology of Animal Parasites (3) I (Identical with V SC 503R)

503L. * Parasitology Laboratory (1) I (Identical with V SC 503L)

504. * Insect Morphology (4) I 1994-95 Internal and external structure of insects as related to function, physiology and evolution. 3R, 5L, P, 201R or invertebrate zoology. Wheeler

505. * Aquatic Entomology (3) II 1994-95 Morphological, physiological and behavioral adaptations of insects to life in water; taxonomy and ecology of aquatic insects. 2R, 3L, Field trips. P, ECOL 182. (Identical with W FSC 505 and ECOL 505) Smith

507R. * Insect Physiology (3) II 1994-95 Introduction to the diverse and unique ways insects solve physiological problems. A whole animal approach will be used centered around various aspects of an insect's life (i.e., growing, flying, reproducing), P, 201; CR, 507L; biochemistry recommended. Hagedorn/Chapman


508. * Insect Toxicology (3) II 1993-94 Introduction to the interactions of insects with natural and synthetic toxicants; metabolism, mode of action and resistance of insects to insecticides. P, 3 units of organic chemistry or biochemistry (Identical with TOX 508) Feyereisen

511. * Insect Behavior (3) II 1993-94 The evolution of arthropod behavior in ecological context. Ultimate causation with some consideration of physiological and morphological constraints. 2R, 3L. Field trips. (Identical with ECOL 511) Smith/Papaj


526. * Bio-Analytical Techniques (2) I 1993-94 Direct hands-on experience with modern instrumentation focused on the isolation, identification, and biological assay of natural products. Interdisciplinary instruction for both chemists and biologists. P, 3 units of organic or biochemistry, 2 courses in biological sciences. (Identical with V SC 425) Bowers

527. * Insect Chemical Ecology (2) I 1993-94 The chemistry of relationships regulating insect growth, development, reproduction, diapause and communication. Derivation of biologically methods of insect control. P, 201, 507 or equivalent, and 3 units of organic or biochemistry. (Identical with V SC 527) Bowers

543. * Insect Neurobiology (3) I The structure, function and development of the insect nervous system. Basic concepts in neurobiology and presentation of insects as model systems of neurophysiology, development and behavior. P, MCB 181, ECOL 182. (Identical with MCB 543) Tobin

554. * Insect Ecology (3) I 1994-95 The study of how variation in the environment, interactions with other species and the special features of insect “design” have determined the evolution of diverse insect life histories, the dynamics of insect populations and the roles of insects in communities. 2R, 3L. Field trips and project. P, 201R. (Identical with ECOL 544) Taylor

552. * Medical-Veterinary Entomology (4) II 1994-95 Survey of arthropods of public health and veterinary importance, with emphasis on transmission dynamics of pathogens, biometrics of vector populations, and current control concepts. 3R, 3L, P, 201; parasitology
The Program in Environment and Behavior includes courses in Entomology, Environmental Toxicology, Insect Ecology and Evolution, Insect Physiology, Biochemistry, Toxicology, Plant-Insect Interactions, Insect Pest Management, and more. The program offers opportunities for research and development of strategies for disease prevention and control. Multidisciplinary collaborations between program faculty and members of university departments and state and national health institutions provide classroom and community training opportunities. To accomplish this goal, faculty program members with overlapping expertise from several health science departments have been selected to direct courses and research.

Degrees

The Graduate Program in Epidemiology offers a major in epidemiology for the Master of Science and Doctor of Philosophy degrees.

Admission Requirements

In addition to an undergraduate degree, applicants should provide scores of the Graduate Record Examination. Three letters of recommendation are required.

515. Subspecialty

h. Cancer Epidemiology and Prevention (3) I, II; none; statistics helpful. (Identical with RONC 515h)

510. Biostatistics for Research (3) I Descriptive statistics and statistical inference relevant to biomedical research, including data analysis, regression and correlation analysis, analysis of variance, survival analysis, biological assay, statistical methods for epidemiology and statistical evaluation of clinical literature. P, STAT 509

650. Quantitative Epidemiology (3) I Study of computer intensive multivariate epidemiologic methods including evaluation of potential etiologic environmental exposures in human populations to the risk of disease. 2R, 1L P, FCM 596r, 596b.

660. Infectious Disease Epidemiology (3) I [Rpt/1] Introduction to epidemiologic methods used in infectious disease investigations. An emphasis will be placed on understanding the relationships between the host, the parasite and the environment as they relate to disease causation. P, FCM 596r, 596b.

670. Chronic Disease Epidemiology (4) II Nutritional epidemiology, pharmacoepidemiology, occupational epidemiology and environmental epidemiology. P, FCM 596r, 596b.

696. Seminar

i. Epidemiology (3) I II [Rpt/8 units]

896. Seminar

b. *Epidemiological Methods (3) II

r. *Basic Principles of Epidemiology (3) [Rpt/1]

r. *Psychosocial Epidemiology (2)

*Available as both 596 and 896.

Exercise and Sport Sciences

(See Health-Related Professions)
Family and Consumer Resources
(FCR/MCS/ID/HEE/COUN/FS)

FCR Building, Room 205
(602) 621-1075

Professors Victor A. Christopherson (Emeritus), Interim Director; Oscar C. Christensen, Roger J. Daldrup (Emeritus), Kathryn L. Hatch, Jean Ruley Kearns (Emerita), Amy Jean Knorr (Emerita), Doris E. Manning (Emerita), Naomi A. Reich (Emerita), Associate Director, Robert R. Rice, Carl A. Ridley, David C. Rowe, Mary Adele Wood (Emerita)

Associate Professors Ellen Goldsberry, Donna R. Iams, Maureen E. Kelly, Roger M. Kramer, Philip J. Lauver, Mary H. Marion (Emerita), Betty J. Newlon, Soyeon Shim, Angela Taylor, Mari S. Wilhelm

Assistant Professors Donna H. Christensen, James E. Deal, Mary Ann Eastlick, Daniel J. Flannery, Wendy Gamble, Lynn Lyon, Susan B. Silverberg

The School of Family and Consumer Resources offers programs leading to the following graduate degrees:

Master of Science with a major in family and consumer resources with concentrations in family studies, home economics education, merchandising and consumer studies;
Master of Science with a major in home economics education;
Master of Home Economics Education with a major in home economics education;
Master of Education with a major in family and consumer resources;
Master of Arts with a major in counseling and guidance;
Doctor of Philosophy with a major in family and consumer resources and a concentration in family studies emphasizing interpersonal relationships, human development, or family economics/consumer resource management.

All applicants are required to submit scores on the aptitude test of the Graduate Record Examination, three letters of recommendation and scores of the Graduate Record Examination. All application materials for fall admission must be received by March 1.

Individual master's programs will be planned with and approved by an advisor. These may vary both in course work and in total units, depending upon the area of concentration and upon past experience and training.

Family Studies: Family studies involves the scientific study of family structures, interactions, and outcomes, emphasizing change over time in individual, interpersonal, and group level phenomena. Emphasis are available in interpersonal relationships, human development, or family economics/consumer resource management.

When students are accepted into the concentration in family studies within the Family and Consumer Resources major for the Ph.D, it is assumed that all graduate and are expected to meet all university requirements for doctoral studies with a major concentration in family studies and a minor from an area outside of the School of Family and Consumer Resources.

Home Economics Education: Programs leading to the Master of Science degree and the Master of Home Economics Education degree with a major in home economics education are available. A minor in home economics education is also available for doctoral students with majors in other disciplines. The Master of Science degree program requires a thesis and no fewer than twenty units in home economics education, family and consumer resources, or education, or a combination. A total of thirty units is required. These programs prepare students for employment in the Cooperative Extension Service at county or specialist level; for teaching at secondary, community college, or university level; for supervision at local and state levels; or for educational positions in business.

Requirements for the degree include two units of seminar, an appropriate course in statistics, a course in research methods, and a thesis of four to six units. Modification of these requirements may be made, with the approval of the student's graduate committee and the director of the School, after consideration of the student's preparation and professional objectives.

Merchandising and Consumer Studies: For the Master of Science degree with a major in family and consumer resources, a concentration in merchandising and consumer studies is available. Students are required to complete 34 units including statistics and research methods, and six units for the thesis. The major components of the course requirements include merchandising management and consumer studies. This program prepares students for pursuing a doctoral degree or for employment in retail firms, consumer service firms, teaching at the secondary-school, community college or university level.

Family and Consumer Resources (FCR)

555. Women in International Development (3) II (Identical with ANTH 565)

566. Seminar z. Family and Consumer Resources (1-3) [Rpt./1] 1 II

Division of Merchandising and Consumer Studies
S. Shim, Chair

Merchandising and Consumer Studies (MCS)

507. Research Methods in Merchandising and Consumer Studies (3) II Research literature, methods, techniques, and procedures for conducting research, and analysis and interpretation of data. P, 3 units of graduate statistics.

534. Strategic Merchandise Management (3) II Application of retail planning and control procedures with emphasis on development and evaluation of retail strategies. P, 315, MKTG 361, MKTG 456 or CR.


555. Visual Merchandising and Display (3) I S All aspects of displaying merchandise, including window display, interior display, color and lighting techniques, line and composition, three-dimensional presentation, fixtures and systems, planning and layout, scheduling and promotion. P, 115 or ART 101

556. Store Planning and Design (3) II Studies the retail environment, taking into account all the physical and psychological effects that
initiate and motivate customer activity. 2R, 3L. P. 455.

*May be convened with 400-level course.

606. International Consumption and Retailing (3) 1 1994-95 Understanding of international market environment and retailing structure, system, issues and trends in the contemporary global market; analysis of cultural, social, legal, political influence on international consumption pattern and retailing process. Developing retailing strategies on a global basis.

607. Topics in Merchandising and Retailing (3) [Rpt./6 units] II 1993-94 Analysis of current major topics or issues facing merchandising and retailing industries. P. 540, 606.

608. Topics in Consumer Issues and Psychology (3) I 1993-94 Exploration of new topics, critical examination of current literature and selectively distributed research reports and analysis of studies in consumer issues and psychology. P. graduate statistics and/or research methods.

634. Retail Merchandising Analysis (3) I 1994-95 Analysis of current literature and case studies of major issues facing retail management.


Counseling and Guidance (COUN)

503. Principles of Adlerian Psychology (3) I Techniques for the study of human behavior; implications for improving adult-child relationships, with emphasis on Adlerian principles. P. 6 units of social science.

550. Counseling and Human Sexuality (3) S Sexual function, dysfunction, and disorders in context of individual and couple; interview techniques and intervention strategies. P. 6 units of counseling or related area.

555. Addictions Counseling (3) S An analysis of issues in addictions counseling ranging from various theoretical positions, information regarding diagnosis of addictive personality, treatment programs, and research. P. 6 units of counseling or related area.

557. Methods in Marital Therapy (3) I (Identical with FS 557)

570. Counseling the Adult (3) I Adult crisis, midlife changes and developmental patterns; counseling techniques and intervention strategies. P. 6 units of counseling or related area.

571. Counseling Women (3) II Examination of the counseling needs of contemporary women and current types of intervention designed to meet these needs. P. 6 units of counseling or related area. (Identical with WS 571)

597. Workshop
  d. Counseling Children and Adolescents (3) S
  f. Professional Relationships: Building Cooperation and Mediating Conflict (3) IS
  k. Psychodrama (3) S P, 6 units of counseling or related area.
  m. Counseling Mexican Americans (3) I S

*May be convened with 400-level course.

601. Foundations of Counseling (3) I Relationship and contributions of various fields to the work of the counselor at all levels, in current and historical perspective; derivation of principles and objectives; integrated laboratory experience in selected settings. Open to majors only.

622. Appraisal of the Individual (3) I Methods of appraising and reporting individual behavior, with emphasis on nonpsychometric data. Open to majors only.

623. Testing in Counseling (3) I Evaluation and selection of psychological tests for guidance; use of psychometric data in counseling. Open to majors only.

631. Career Counseling (3) I Theories of vocational development; types, sources, and use of educational and occupational information in career counseling and decision making. P. 601 or CR.

644. The Counseling Process (3) II Introduction to theories of counseling; collation and interpretation of counseling data; the counseling process; study of cases. P. 601, 622.

645. Theories of Counseling (3) II Rationale, development, and research underlying major counseling theories. P. 631, 644.

647. Premarriage and Marriage Counseling (3) I Contemporary issues, concepts, and procedures in premarriage and marriage counseling. P. 622.

648. Procedures in Family Counseling (1 to 3) I II Theory and process in family counseling; problem solving techniques applied to parent-child conflict; laboratory experience. P. 403.


672. Cross-Cultural Counseling (3) II Issues, research and procedures involved in counseling with culturally different persons. Open to majors only: P. 601, 622.

683. Group Counseling (3) I Theory and process in group counseling; applications in community and mental health settings; laboratory experience. P. 644.

696. Seminar
  e. Ethics and Professional Practice (3) I Open to majors only: P. 601, 622, 644.
  r. Issues in Counseling Research (3) I Open to majors only: P. 601, 622, and 623 or 631.

Division of Family Studies (FS)

D. Rowe, Division Chair

500. Life Span Development (3) II (Identical with ED P 500).

503. Advanced Adolescent Development (3) II (Identical with ED P 503)

507a-507b. Research Methods in Family Studies (3-3) 507a: I Design issues of general relevance to behavioral research. 507b: I Design issues of particular relevance to family and developmental research. Both 507a and 507b are offered in the fall semester only.

523. Socio-Cultural Context of Human Development (3) II Examination of the social and cultural contexts of individual development, including family, community, peers, school, and ethnic groups as well as the influence of social class and economic conditions. Special attention given to socialization and development of ethnic-American children and adolescents. P. 117. (Identical with ED P 423)

537. Analysis of Family Studies (3) I An analysis of major research topics; critical resources relevant to graduate training; and ethical/professional issues related to the conduct of research.

547. Advanced Child Development (3) I In-depth examination of various dimensions of human growth and development. P. 223; 6 units of psychology.

557. Methods in Marital Therapy (3) I Theories and principles of counseling for premarital, marital, and group counseling situations. (Identical with COUN 557)

566. Family Economics (3) I Analysis of the family as an economic-decision-making unit within the larger economic system. P. ECON 201b.

567. Theories of Human Development (3) II Analysis of major paradigms and world views influencing the study of human development. Overview of key issues and controversies arising in the field as well as evaluations of specific theories and specific theorists.

573. Theories of the Family (3) II Major theories of the family to include theory construction, historical roots of family theories, and classic and contemporary family theories. P. 9 units of family studies, psychology, or sociology.

577. Genetic Basis of Normal and Deviant Traits (3) II Explores methods of studying genetic influences on human traits and summarizes research findings on normal traits, such as sociability and IQ, and on deviant traits such as criminality. Implications for the fields of family studies, sociology, and psychology are considered.

587. Advanced Family Relations (3) II Critical analysis of selected studies and current research in family relations. P. 337, or SOC 321.

*May be convened with 400-level course.

607. Topics in Family Studies (1 to 3) [Rpt./3] I II Variable content: cognitive development, biological theories of development, role theory, middle childhood, and others.

613. Issues in Aging (3) II 1994-95 Critical analysis of selected family and social issues, and related current research in gerontology (Identical with GERO 613)
636. Economics of Aging (3) I Analysis of economic issues and policy as they affect the aging individual, family, and society. (Identical with GERO 636)

637. Trends in Human Relations (3) Philosophy, content, and resources for understanding, teaching and working in the field of human relations.

646. Theories of Family Economic Behavior (3) I Analysis of theories relevant to family economic behavior including theories on poverty, economic well-being, family systems, and decision making. Emphasis on social psychological concepts.

Home Economics Education (HEE)


528.* Professional Presentations and Techniques (3) I II Theory and practice of educational techniques in non-formal settings in positions in business, government and human services. 2R, 3L.

539.* Non-Formal Education (3) II (Identical with A ED 539)

597. Workshop
a. Administration, Management, and Supervision of Non-formal Education (1) [Rpt/3] (Identical with A ED 597d, which is home)

b. Computer Applications in Agricultural and Non-formal Education (1) [Rpt/3] (Identical with A ED 597g, which is home)

c. Family Development through Home Economics Programs (1-3)

d. Financial Institutions (3) I II

585.* Ethics and Practice for Interior Design (3) II Readings in the interior fields, with emphasis on ethics, business organization, communication and professional development. Includes study of billing and fee structures, writing proposals, contracts, specifications; and highlights various career tracks associated with the design profession. P, 475.

588.* Advanced Public Space Design (4) II Studio projects with special focus on large-scale multifunction public space environments; design development by teams. P, 475.

*May be convened with 400-level course.

Finance and Real Estate (FIN)

McClelland Hall, Room 315R (602) 621-7554

Professors Edward A. Dyl, Head, Willard T. Carleton, Nestor R. Roos (Emeritus)

Associate Professors Erich K. Bleck (Emeritus), Joseph S. Gerber (Emeritus)

Assistant Professors Allen B. Atkins, Robin J. Brenner, Corinne M. Bromman, Richard H. Harjes, Simon H. Kwan, Joel S. Sternberg

The department offers programs leading to the Master of Science degree with a major in finance. The department also participates in the programs leading to the Master of Business Administration and the Doctor of Philosophy degree with a major in management. For information concerning these degrees, see "Requirements for Master's Degrees/Master of Business Administration" and the handbook of Business Administration elsewhere in this catalog.

For admission, the applicant is expected to have completed undergraduate work in managerial accounting, economics, finance, marketing, organizational behavior, production, business policy, statistics, and mathematics through calculus (Math 119 and 123). A score on the Graduate Management Admissions Test in the ninetieth percentile or above and an academic average of approximately "B" or better are required for admission consideration.

The program for the Master of Science degree with a major in finance includes a minimum of sixteen units at the 500 level and either a thesis or a research report.

511. Managerial Finance (3) I II Integration of the basic principles and underlying theory of finance, with emphasis on analytical financial management of business firms and other organizations. Open only to students admitted to a BPA graduate program. P, ACCT 550.

512. Advanced Corporation Finance (3) II Financial theory applied to capital structure; investments decisions; corporate valuation; and corporate financial policies. P, 412 or 511.


528. Topics in Public and Nonprofit Financial Management (3) II (Identical with PA 528)


537. Finance for New Ventures (3) I Value maximization; simulation of value distribution; sources of venture capital; timing of initial public offering; new venture ownership structuring. Open only to students in the entrepreneurship program. P, 511, Mktg. 500. (Identical with MAP 537)

539. Planning of New Ventures (3) II (Identical with MAP 539)


695. Colloquium
a. Research and Finance (1-3) [Rpt/4] I II

696. Seminar
a. Investments (3) [Rpt/1] I II
b. Financial Markets (3) [Rpt/1] I II
c. Corporation Finance (3) [Rpt/1] I II
d. Financial Institutions (3) I II
e. Financial Theory (3) [Rpt/1] I II
f. Research Methods (3) [Rpt/1] I II

697. Workshop
a. Research Issues (1-3) [Rpt/5] I II. P, admission to a graduate program in BPA.

French and Italian (FREN/ITAL)

Modern Languages Building, Room 549 (602) 621-7349

Professors Jonathan Beck, Frank M. Chambers (Emeritus), Monique Wittig
Associate Professors Robert A. Ariew, Edward G. Brown, Ingeborg M. Kohn, Lise Leibacher, Henri Servin, Gianni Spera, Ronnie H. Terpening
Assistant Professors Brunella Bigi, Irene S. d’Almeida, S. Prosper Sanou

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in French. In cooperation with the College of Education, the department also offers courses leading to the Master of Education degree with a major in French. For information regarding this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog. A doctoral minor is available in French.

The department cooperates with the Arizona Center for Medieval and Renaissance Studies.

Admission to graduate programs in French requires the completion of a bachelor's degree with a major in French. Applicants must submit scores on the aptitude test of the Graduate Record Examination. Admission to a doctoral program is dependent upon the completion of a Master of Arts degree with a major in French. Students with a master's degree from another institution must take a qualifying examination during the first two weeks of residence.

Degrees

Master of Arts (Major in French): Students must complete at least 32 units of course work. A thesis is not required. Concentrations are available in the literature of France and Francophone literature. Candidates must pass a final written and oral examination.

Doctor of Philosophy: The major in French consists of a minimum of 50 units of graduate course work in the department in addition to the dissertation. The minor, consisting of 15 or more units, may be taken within the department or in a field approved by the department. All students are required to demonstrate knowledge in two other foreign languages. After successful completion of the written and oral preliminary examination, each candidate will write and defend a doctoral dissertation.

French (FREN)

510. Introduction to Graduate Study in French Language and Literature (3) I 1993-94 Problems and methods of advanced research in French language and literature. Use of specialized library resources and computerized data bases. Issues in the history, sociology, and politics of the professional practice of language and literature study in American universities.

511. Contemporary French Literary Theory (3) II 1993-94 Methods of criticism and techniques of literary analysis.

515a-515b. Literature of the 20th Century (3-3) 1994-95 515a: Novel. 515b: Poetry and drama. 515a is not prerequisite to 515b.

516a-516b. Literature of the 19th Century (3-3) 1994-95 516a: Poetry and theatre. 516b: Novel and short story; intellectual current. 516a is not prerequisite to 516b.

517a-517b. Literature of the 18th Century (3-3) 1993-94 Study of ideas in the French Enlightenment. 517a: Rationalist currents. 517b: Sensibility. 517a is not prerequisite to 517b.

518a-518b. Literature of the 17th Century (3-3) 1993-94 518b: Literature and culture in the first half of the 17th century. 518b: The Classical ideal. 518a is not prerequisite to 518b.

519a-519b. Literature of the 16th Century (3-3) 1993-94 519a: Early Renaissance, Reformation, Rabelais, the Pleiad. 519b: The Humanists, Montaigne, D'Aubigne, the drama. 519a is not prerequisite to 519b.


548. Theory and Practice of Writing (3) II 1993-94 An experiment in writing, concerning the means, the raw material at our disposal and the different literary devices that allow us to achieve it. (Identical with ENGL 548)


553. * Culture and Civilization of North Africa (3) I II 1993-94 Historical, religious, social, literary and artistic influences on the civilization of North Africa. P, 305b if 553 is taught in French.


579. Problems in Teaching College French (1 to 3) I II Methodology course in lower-division college pedagogy. Discussion of broader issues of language, pedagogy, aca-
demic, the history of foreign language edu-
cation, college teaching as a career.

585. * Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II

587. Testing and Evaluation in Foreign/Second Language Programs (3) (Identical with GER 587)

*May be convened with 400-level course.

696. Seminar

a. ** French Linguistics (3) [Rpt.] I II
b. ** Foreign Language Pedagogy (3) [Rpt.] I

c. ** French Literature: General Topics (3) [Rpt.] I

d. ** Old French Literature (3) [Rpt.] I

e. ** Sixteenth Century (3) [Rpt.] I

f. ** Seventeenth Century (3) [Rpt.] I II

g. ** Eighteenth Century (3) [Rpt.] I II

h. ** Nineteenth Century (3) [Rpt.] I II

Italian (ITA)


505a-505b. * French and Italian- Genetics 79


*May be convened with 400-level course.

Genetics (GENE)

Biosciences West Building, Room 310 (602) 621-7511
Graduate Interdisciplinary Program in Genetics

Committee:

Professors Harris Bernstein (Microbiology and Immunology), Robert P. Erickson (Pediatrics), William B. Heed (Emeritus), Conrad Istock (Ecology and Evolutionary Biology), Margaret G. Kidwell (Ecology and Evolutionary Biology), Brian A. Larkins (Plant Sciences), John W. Little (Biochemistry, Molecular and Cellular Biology), Robert G. McDaniel (Plant Sciences), Neil H. Mendelson (Molecular and Cellular Biology), Richard E. Michod (Ecology and Evolutionary Biology), David W. Mount (Molecular and Cellular Biology), David C. Rowe (Family and Consumer Resources), Nobuyoshi Shimizu (Molecular and Cellular Biology), Hans VanEtten (Plant Pathology), Samuel Ward (Molecular and Cellular Biology)

Associate Professors Dennis T. Ray, Chair, (Plant Sciences), Danny L. Brower (Molecular and Cellular Biol-
Geneticists from various departments comprise the interdepartmental Program in Genetics, which offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in genetics. The areas of study emphasized by the program are molecular and cellular genetics, cytogenetics and population genetics. Research opportunities include bacterial and bacteriophage genetics, gene regulation, developmental plant genetics, plant and animal cytogenetics, somatic cell genetics, cancer and clinical cytogenetics, quantitative genetics and animal breeding, ecological and evolutionary genetics, population genetics, human genetics and biometrical principles as applied to individuals and populations.

Admission requirements include: completion of bachelor's degree with one year of biology, courses in genetics, ecology, physiology and developmental biology, chemistry through organic, mathematics through integral calculus, introductory physics and statistics. In addition to materials required by the Graduate College, applicants are required to furnish the program with completed Committee on Genetics application forms, GRE scores on quantitative and verbal tests, and three letters of recommendation from persons qualified to evaluate the applicant's scholarly potential. The deadline for receipt of application forms for fall admission is April 1 and for spring admission, November 1. Courses are available in a number of departments depending on the interests of the students.

509. Statistics for Research (4) I II (Identical with STAT 509)
513. Quantitative Genetics (3) I 1994-95 (Identical with AN S 513)
515.* Somatic Cell and Molecular Genetics (2) II (Identical with MCB 515)

516.* Computer Analysis of Sequences (3) II (Identical with MCB 516)
520. History of Genetics (1) I 1994-95 Experiments and discoveries which have led to the present state of knowledge in the various areas of genetics. P, ECOL 320 or 321.
523.* Cytogenetics (3) II (Identical with ECOL 523)
524. Theoretical Population Genetics (3) I (Identical with ECOL 524)
525. Speciation (2) II (Identical with ECOL 525)
533.* Human Genetics (3) I Genetic theory and technique, as applied to man; methods of analysis of genetically determined cytological and biochemical differences in individuals and populations. 2R, 3L. P, ECOL 320 or 321. (Identical with ECOL 533) Ward
535.* Evolution (3) I (Identical with ECOL 535)
545. Concepts in Genetic Analysis (3) I (Identical with MCB 545)
546.* Molecular Genetics and Evolution (3) II 1994-95 (Identical with MCB 546)
555. Molecular Mechanisms of Development (3) II 1994-95 (Identical with MCB 555)
568. Nucleic Acids (4) I (Identical with BIOC 568)
570. Molecular Genetics and Evolution (3) I 1993-94 (Identical with MBIM 570)
574. Advances in Mammalian Genetics (2) [Rpt.] I 1994-95 (Identical with BIOC 574)
589. Cancer Genetics and Cytogenetics (3) I 1993-94 (Identical with MCB 589, which is home)
595. Colloquium
a. Genetics (1) [Rpt.] I II

601. Molecular and Cellular Biology (4) I Acquire a basic understanding of modern genetics, molecular biology and cell biology, and learn how to apply that understanding to human disease. (Identical with MCB 601, which is home) P, consult department before enrolling.
627. Advanced Genetics (3) II 1994-95 (Identical with PL S 627)
635. Advanced Cytogenetics (4) I 1994-95 (Identical with PL S 635)
666. Human Microevolution (3) II 1994-95 (Identical with ANTH 666)
670. Recent Advances in Genetics (2) II Recent advances in the field of genetics. (Identical with ECOL 670)
695. Colloquium
e. Science, Society and Ethics (1) I II (Identical with MCB 695e, which is home)

Geography and Regional Development (GEOG)
Harvill Building, Room 409
(602) 621-1652
Professors David A Plane, Head, Michael E. Bonine (Near Eastern Studies), Terence Burke, Robert D. Carpenter (Emeritus), Lay J. Gibson, Andrew M. Kirby, Lawrence D. Mann, Gordon F. Mulligan, Leland R. Pederson, Richard W. Reaves, Thomas F. Saarinen, Dan Stanislawski (Emeritus), Andrew W. Wilson (Emeritus), Ervin H. Zube (Renewable Natural Resources)

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in geography. In cooperation with the College of Education, the department offers work leading to the Master of Education degree with a major in geography. The department also offers work in regional planning leading to the Master of Science degree with a major in planning.

All applicants are required to submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Admission to the Doctor of Philosophy degree program requires the recommendation of the committee administering the final examination for the Master of Arts degree or, if the master's degree was earned elsewhere, admission is subject to completion of Geography 500, 657, and 689 with a grade of B or better.

Degrees
Master of Arts: A total of 30 units of graduate credit, to include (1) a core of 9 units made up of 500, 657, and 689; (2) a minimum of 12 units of graduate work in geography exclusive of both core and thesis, at least 6 of which must be in courses or seminars exclusive to graduate students, i.e., not convening 400/500 courses, and not independent studies; and (3) an additional 9 units of approved electives, which may include up to 6 units of thesis, which is optional. Students electing the thesis option must pass a final oral examination; those electing the non-thesis option must pass a written and oral comprehensive examination.

Master of Education: A total of 17 units of geography including 500 and 689, and 11 additional approved units, to include at least one regional and one topical course. No thesis is required, but candi-
can planning as a response to urbanization. Open to majors only. Credit allowed for this course or 301, but not for both. (Identical with PLNG 510) Mann

511. Middle America (3) II Land, man, and culture in the major natural and cultural regions of Mexico, Central America, and West Indies. (Identical with LA S 511) Pederson

512. South America (3) I Physical and cultural bases of South America's geographic patterns, with emphasis on human settlement and problems of resource development. (Identical with LA S 512) Pederson

513. Africa (3) II Physical and human bases of regional contrasts, with emphasis on tropical environmental systems and changing patterns of resource utilization and development. Altschul

515. * Introduction to Water Resources Policy (3) II (Identical with HWR 515)

516. * Rural Area Development (3) I (Identical with AREC 516)

517. * Introduction to Geographic Information Systems (3) II (Identical with RNR 517)

518. * Advanced Geographic Information Systems (3) II (Identical with RNR 518)

531. Global and Regional Climatology (3) II 1994-95 Description and analysis of the atmospheric circulation process that produces differences in climates throughout the world. Emphasis on the earth's problem climates and climatically sensitive zones most susceptible to floods, droughts, and other environmental stresses due to global change. P. ATMOL 171; GEOG 171 or GEOG 163a.

550. Metropolitan and Regional Planning (3) II Survey and evaluation of concepts and examples, including metropolitan, economic development, state and national, and environmental plans in the U.S. and abroad. (Identical with PLNG 550) Mann

553. Locational Analysis (3) II Industrial location theory and location factors, consumer travel behavior and market areas, geography of economic impacts, location of public facilities. (Identical with PLNG 553) Mulligan

556. Urban Systems Analysis (3) II Theoretical and applied analysis of urban growth models, gradients of urban influence, residential and facility decisions, and urban transportation. (Identical with PLNG 556) Marston

557. * Statistical Techniques in Geography, Regional Development and Planning (3) I Methods of gathering and analyzing data for the solution of geographical, urban, and regional planning problems, with emphasis on quantitative and statistical techniques used in spatial analysis and cartography, on the one hand, and program planning, on the other. (Identical with PLNG 557)

559. * Land Use and Growth Controls (3) II Current planning and legal techniques to regulate the rate of growth, the sequence of growth, and the eventual total size of towns, regions, and states; concentration on case studies. (Identical with PLNG 559) Mann

561. Resource Management (3) I Examination and critical appraisal of social and behavioral science aspects of resource management, with special emphasis on factors affecting decision making. (Identical with PLNG 561) Saarinen

563. Perception of Environment (3) II Examination of interdisciplinary research on environmental perception; consideration of social and behavioral variables at all scales of environmental perception and planning. (Identical with PLNG 563) Saarinen

564. * The Arid and Semiarid Lands (3) I Past, present, and future of settlement and resource utilization in the world's arid lands; spatial interrelationships of environmental, demographic, socioeconomic and political systems. (Identical with AR L 564) Bonine

565. * Physical Aspects of Arid Lands (3) I The climate, landforms, hydrology, soil, vegetation of deserts, with special emphasis on processes and distribution at micro-tomacro scales. (Identical with AR L 565) Reeves

567. Geographical Analysis of Population (3) II Population distribution and change; practical methods of demographic analysis, migration, business and planning applications. (Identical with PLNG 567) Plane

571. * Problems in Regional Development (3) II Analysis of population growth trends, market areas, the role of transportation in development, regional specialization and economic structure, interregional migration, and regional policy issues. (Identical with AREC 571 and PLNG 571) Mitchneck


578. * Global Change (3) II (Identical with GEOS 578)

581. * Computer Cartography (3) II Introduction to the use of computers for map production, with emphasis on cartographic principles and practical experience with several user-oriented mapping programs. (Identical with PLNG 581)

583. * Geographic Applications of Remote Sensing (3) II Use of aircraft and satellite imagery for monitoring landforms, soils, vegetation and land use, with the focus on problems of land-use planning, monitoring management and related topics. 2R, 3L. Field trip. P, two units of remote sensing or equivalent experience. (Identical with PLNG 583) Marsh

590. * Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

596. Seminar

k. Risk and Society (3) I (Identical with ANTH 596k, JOUR 596k, HWR 596k) Waterstone

u. Interdisciplinary Environment-Behavior Design (3) II (Identical with ENV 596u, which is home)

597. Workshop

a. * Geography for Teachers (3) S

May be repeated for 400-level course.

605. Planning Theories and Perspectives (3) I A critical examination of normative and
methodological assumptions of alternative planning models, with emphasis on developing a perspective on contemporary planning issues. (Identical with PLNG 605) Mann

611. Projects in Regional Planning (1 to 5) [Rpt.5 units] II Lectures, laboratory, and field projects covering various aspects of professional practice. P. 605, 24 units toward a graduate degree in planning. Field trips. (Identical with PLNG 611) Mann

657. Spatial Analysis (3) II Formal analysis and modeling of spatial structures and processes; conceptual evaluation of point patterns, networks, surfaces and interaction. P. 457 or 557. (Identical with PLNG 657) Mulligan

689. History of Geographic Thought (3) II History of geographic philosophy and methodology. P. 15 units of geography. Pederson

696. Seminar
a. Economic Geography (3) [Rpt./2] I II
b. Cultural Geography (3) [Rpt./2] I II
c. Physical Geography (3) [Rpt./2] I II
d. Area Study (3) [Rpt./3] I II
f. Research Methods (3) [Rpt./2] I II
g. Urban Geography (3) [Rpt./2] I II

Geological Engineering
(See Mining and Geological Engineering)

Geology
(See Geosciences)

Geosciences (GEOS)
Gould-Simpson Building, Room 208
(602) 621-6024


Assistant Professors Mark D. Barton, Andrew Cohen, Owen K. Davis, George E. Gehrels, Randall M. Richardson, Joaquin Ruiz, Robert Singer (Planetary Sciences)

Assistant Professors Lawrence M. Anovitz, Suzanne Baldwin, L. Susan Beck, Roy A. Johnson, Jay Quade

Laboratory of Tree Ring Research
West Stadium Building, Room 109
(602) 621-6469

Professors Malcolm K. Hughes, Director, Bryant Bannister (Emeritus), Jeffrey S. Dean, Harold C. Fritts (Emeritus), William J. Robinson (Emeritus), Charles W. Stockton, Marvin A. Stokes (Emeritus)

Associate Professor Steven W. Leavitt
Assistant Professors Lisa J. Graumlich, Thomas W. Swetnam

The Department of Geosciences offers graduate studies leading to the Master of Science and the Doctor of Philosophy degrees with a major in geosciences.

Applicants for graduate degrees must have completed the baccalaureate with a major in geosciences or in an allied discipline. All applicants must submit their scores on the General Graduate Record Examination directly to the department and provide three letters of recommendation and a personal resume including a statement of proposed academic and research activities. Application materials are available from the department.

Degrees

Master of Science: Designed to train students aspiring to professional employment in industry; in local, state or federal government; or in teaching profession at the community college level. The program also serves as a foundation for graduate studies continued beyond the M.S. level, especially for those students whose M.S. research experiences are vital to their professional growth and for those who develop strong research interests and abilities. Requirements include 30 units of course work. A thesis or pre-publication manuscript is required.

Doctor of Philosophy: Designed for students who plan to work as professional geoscientists in research-oriented capacities in the academic community, industry, or government. Qualified students with a bachelor's degree or a master's degree may be accepted into the Ph.D. program. Requirements include 36 units of credit in addition to 18 units of dissertation credit. A dissertation is required. A twelve-unit minor is required in a related subject.

The department handles admissions and student advising through six curriculum committees. Students working toward an advanced degree in geosciences should concentrate in one or more of the following areas:

Economic Geology: Ore deposit petrology, especially copper and gold systems; hydrothermal ore deposits; fluid inclusion studies; stable isotope analysis; alteration petrology/geochemistry; plate tectonics and ore deposits; mathematical theory of magma hydrothermal systems; dynamic models of intrusion and fluid movement.

Geophysics: Earthquake and reflection seismology; inverse theory; potential fields; plate-dynamics; earth structure; crustal mechanics and evolution; paleomagnetism; floral isotasy and erosional processes.

Mineralogy-Petrology-Geochemistry: Microstructures of minerals; crystal chemistry; experimental mineralogy and petrology; the effects of stress on the kinetics and mechanisms of mineral reactions; thermodynamics and kinetics of the evolution of rocks and minerals; thermal evolution of rocks; crustal genesis; trace element geochemistry; isotope geochemistry; geochronology; geochemistry and petrology of the mantle; geochemistry of hydrothermal processes; organic geochemistry of kerogen, amino acids and the early history of life.

Quaternary-Paleoenvironmental Studies: Paleoecology; paleoclimatology; environmental geology; palynology; dendrochronology; radiocarbon dating; stable isotope geochemistry; quaternary geology-stratigraphy.

Stratigraphy-Paleontology: Sedimentary petrology; depositional environments; basin analysis; stratigraphy; biostratigraphy; paleobiology, invertebrate and vertebrate paleontology; paleoecology and evolution.

Tectonics: Regional tectonics; tectonic geomorphology; structural geology; sedimentary tectonics; tectonophysics; geochronology; tectonic implications of paleomagnetism.

In addition there are three interdisciplinary programs:

Archaeological Geology: Quaternary stratigraphy, geomorphology, geologic processes, dating techniques, and environmental reconstructions in relation to the archaeological record. In conjunction with the Department of Anthropology, archaeological method and theory, and modern geoarchaeological techniques.

Geohydrology: Geologic and geophysical characteristics of aquifers and basins; chemical and isotopic studies of water; mineral-water reactions; remote sensing; aquifer modeling.

Planetary Geology: A concentration through the departments of Geosciences and Planetary Sciences. Geomorphology
and cratering of planetary surfaces; geochemo-
ical evolution of planetary bodies; geo-
chemistry/cosmochemistry and thermal
histories of meteorites; organic geo-
chemistry of the solar system; stress
modeling in planetary bodies; planetary
geophysics; planetary resources.

500,* Introduction to Geochemistry (3) I
Nuclear systematics and thermodynamics
with applications to geologic processes. P, 101, 103;
CHEM 103b, 104b. Ruiz

503,* Introduction to the Solar System (3) I
1993-94 (Identical with PTYS 503)

504,* Petrographic Techniques (3) I Introduc-
tion to application of modern petrographic
techniques. Use of optical theory, optical
petrography, electron microprobe and image
processing to examine and describe minerals
and other materials. 2R, 3L. Anovitz

505. Applied Multispectral Imagery (3) II
(Identical with G EN 505)

506,* Conservation Biology (3) II 1992-93
(Identical with ECOL 506)

507,* Photogeology (3) II (Identical with G EN
507)

508,* Mammalian Phylogeny and Evolution
(3) II 1994-95 A study of the mammalian fossil
record, with emphasis on taxonomy and mor-
phological evolution of selected mammal
orders. 2R, 3L. Field trips. Lindsay

509a-509b. Petrology (3-3) II Earth composi-
tion; spatial and temporal distribution of rock
types; 509a*: Igneous Petrology I Application
of physical and isotopic principles to magmatic
Ruiz 509b: Metamorphic Petrology II 1993-94
Application of physical and isotopic
principles to metamorphic processes. P, 315,
405, CHEM 480a. 509a is not prerequisite to
509b. Ganguly

510. Principles of Cosmochemistry (3) I
1994-95 (Identical with PTYS 510)

514. Late Quaternary Geology (3) I Paleoe-
volution and geochronology of Late
Quaternary alluvium as read from the strat-
igraphic records and geomorphology at key
localities in North America. The interaction of
fluvial and aeolian processes in the eastern
Sahara will be evaluated using enhanced
LANDSAT and Shuttle Imaging Radar. Do-
mestic field trips. Enrollment limited to 10
students. P, 102, 104. (Identical with ANTH
514) Hayes

516,* Field Studies in Geophysics (3) I II S
(Identical with G EN 516)

517,* Sedimentary Basin Analysis (3) II Strat-
igraphic sedimentological, paleogeographic,
and paleotectonic evolution of sedimentary
basins with attention to facies relations, depo-
sitional systems, and structural and plate tec-
tonic framework. P, 302. Parrish

518,* Advanced Mineralogy (3) I 1994-95
Structure and crystal chemistry of minerals,
microstructural development, kinetics and
mechanisms of mineral reactions and trans-
formations, with application to determining
geologic history of rocks. P, 209 or consult
department before enrolling. Snow

519,* Global Tectonic Processes (3) II Plate
tectonics; thermal properties and processes
in the Earth, mechanical behavior of lithosphere
and mantle; global gravity and geoid. P,
MATH 254; PHYS 121. (Identical with PTYS
519) Richardson/Chase

520. Meteorites (3) II 1994-95 (Identical with
PTYS 520)

521,* Tectonometamorphism (3) II 1993-94 In-
roduction to the use of thermodynamics and
kinetics in constraining the P-T-t variables
controlling subsolidus processes. Application
of these results to interpretations of regional
tectonics and the thermal evolution of planeto-
ary bodies. P, consult with department before
enrolling. Anovitz

522. Well Logging Interpretation (3) II (Iden-
tical with G EN 522)

523,* Regional Structural Geology (3) [Rpt.]
I Geologic mapping in a variety of rock types
and structural regimes, with emphasis on the
recognition and solution of regionally signifi-
cant structural problems. Field trips. P, 413.
Gehrels

524.* Paleomagnetism: Principles and Ap-
lications (3) II Physical basis for remanent
magnetism in rocks, techniques of sample col-
lection, measurements, and statistical treat-
ment; review of polarity time scale, apparent
polar wander, plate tectonics. P, PHYS 103b or
116. Butler

525.* Regional Tectonics (3) I Discussion of
the geology, geophysics, petrology, and geo-
chemistry of different types of orogenic sys-
tems and their tectonic evolution. Methods of
tectonic regionalization and integration based
on lithotectonic assemblages and terranes,
and regional structural geology. Plate tectonic
regimens and kinematics. Coney

526.* Cordilleran Tectonics (3) II Geologic
and tectonic evolution of the North American
cordilleras based on analysis of geologic, pale-
magnetic, and paleobiogeographic con-
strasts and tectonic models. Gehrels

527. Orogenic Systems (3) II An analysis of
the geology, geophysics, and geochemistry,
and the tectonic evolution of selected world
mountain systems ranging from currently ac-
tive belts in both oceanic and continental set-
tings back through Phanerozoic, Proterozoic,
and into Archean time. Coney

528. Geologic Characteristics of Ore Occur-
rence (3) I 1994-95 Geological, geochemical
and geophysical signatures of ore occurrence
at the scales of tectonic settings, provinces,
districts, and mines. Field trips. P, CR,
446/546. Titley

529.* Scanning Electron Microscopy (2) In-
duction to the principles and methods of
Scanning Electron Microscopy/Energy Dis-
persive Spectrometry and Image Analysis for
geological/paleontological samples. Students
will have the opportunity to conduct original
research in SEM/EDS/IA as a portion of the
laboratory. 2R, 3L

530. Chemical Evolution of the Earth (3) I
Chemical differentiation and evolution of
earth's mantle and crust according to major-
element, trace-element and isotopic charac-
teristics of neodymium, hafnium, strontium,
lead and other isotopes. (Identical with PTYS
530) Patchett

531.* Hydrogeology (3) I II (Identical with
HWR 531) Davis

532.* Introduction to Seismology (3) I Funda-
mentals of earthquake seismology; wave
propagation, interpreting seismograms, and
quantifying earthquake sources. P, MATH
254. Wallace

533.* Exploration Geophysics: Seismic
methods (3) II Fundamental theory and tech-
niques of seismic reflection and refraction
data acquisition; introduction to data process-
ing and interpretation. P, MATH 254. Johnson

535. Advanced Subsurface Hydrology (3) II
(Identical with HWR 535)

536. Ground Water Resource Evaluation (3) II
(Identical with ECOL 538)

539. Analytical Methods in Geophysics (3) II
1994-95 Transform theory, spectral analysis,
asymptotic series, special functions, proba-
bility. Applications to geophysical problems.
P, MATH 422b. Wallace

540.* Geodynamics (3) II [Rpt.] Large-scale
tectonic problems approached by combined
general and geologic analysis in regional
context. P, 20 units of geology, including 321,
3 units geophysics, MATH 254; consult with
department before enrolling. Chase

541. Soil Genesis (3) II (Identical with S W
541)

542. Ore Depost Petrology (3) II 1994-95
Orthomagmatic, porphyry base metal, skarn,
and leached capping lithologic-mineralogical
studies by petrographic microscope, electron
probe, and advanced techniques. 1R, 6L. P,
425/525 or CR, 646a. Guilbert

543. Mathematical Theory of Magma-
Hydrothermal Systems (3) I Dynamics and
chronology of natural systems are recon-
structed using mathematical systems and
computer models to represent the redistribu-
tion of thermal and mechanical energy
around magma chambers. Norton

545. Geochemoal Processes in Magma-
Hydrothermal Systems (3) II Migration of
chemical components in natural fluid-rock
systems are analyzed using the geochemical
test that represents irreversible, equilib-
rium and advection mass transfer. Norton

546.* Economic Mineral Deposits (3) II Geol-
ogy of metallic and nonmetallic ore deposits.
Economic considerations, processes of forma-
tion, methods of study and exploration, and
description of geologic aspects and settings of
representative worldwide examples. Field
trips. P, 209, 321. Guilbert/Titley

547.* Industrial Minerals and Rocks (3) I
1994-95 Geology, origin, mode of occurrence,
and methods of evaluation of nonmetallic
crystal deposits. 2R, 3L. P, 446. Guilbert

548.* Geophysical Exploration and Engineer-
ing (3) I (Identical with G EN 549)

549.* Mineral Exploration (3) I 1993-94 (Iden-
tical with G EN 549)
583. Thermodynamics in Geosciences (3) I Principles of classical and elementary statistical thermodynamics. Thermo-chemical and -physical properties; equations of states for solids and gases; solutions; phase equilibrium; nonideal multicomponent systems with emphasis on geological and planetary problems. P, MATH 125a-125b, or 124, MATH 119 and/or consult with department before enrolling. (Identical with PTYS 583) Ganguly

590. *Remote Sensing for the Study of the Planet Earth (3) I 1993-94 (Identical with REM 590)

595. *Colloquium
b. Global Climate Change (2) I (Identical with MATH 595b, which is home)
c. General Circulation Observations and Modeling (3) II (Identical with MATH 595c, which is home)
d. Dendrochronology: Physical Applications (3) [Rpt./2] I Use of tree-ring data to study climatic, hydrologic and geomorphic variation. (Identical with WS M 595e)
f. Dendrochronology: Biological Applications (3) [Rpt./2] II Discussion of wood features that are interpretable in terms of climatic and environmental processes; application of tree-ring data to ecological problems; biological basis of wood formation. (Identical with WS M 595f)
g. Dendrochronology: Chronometric Applications (3) [Rpt./2] II Application of tree-ring dating to archeological and environmental problems. (Identical with WS M 595g)

596. Seminar
a. Petrography-Petrology (1-4) [Rpt./6 units] I II
b. Structural Geology (1-4) [Rpt./6 units] I II
c. Mineral Deposits (1-4) [Rpt./6 units] I II
d. Petroleum Geology (1-4) [Rpt./6 units] I II
e. Tectonics (1-4) [Rpt./6 units] I II
f. Mineralogy-Crystallography (1-4) [Rpt./6 units] I II
g. Vertebrate Paleontology (1-4) [Rpt./6 units] I II
h. Paleontology (1-4) [Rpt./6 units] I II
i. Paleontology-Paleoenvironments (1-4) [Rpt./6 units] I II
j. Geomorphology (1-4) [Rpt./6 units] I II
k. Geodynamics (1-4) [Rpt./6 units] I II
l. Geomathematics (1-4) [Rpt./6 units] I II
m. Sedimentology (1-4) [Rpt./6 units] I II
n. Stratigraphy (1-4) [Rpt./6 units] I II
o. Regional Tectonics (1-4) [Rpt./6 units] I II
p. General Geochronology (1-4) [Rpt./6 units] I II
q. Quaternary Geochronology (1-4) [Rpt./6 units] I II (Identical with ANTH 596r)
r. Sedimentary Petrography (1-4) [Rpt./6 units] I II
s. Organic Geochemistry (1-4) [Rpt./6 units] I II
u. Inorganic Geochemistry (1-4) [Rpt./6 units] I II
v. Dendrochronology (1-4) [Rpt./6 units] I II
w. Paleobotany (1-4) [Rpt./6 units] I II
x. Paleobiology (1-4) [Rpt./6 units] I II

561. Paleopoenntian Origins (3) I (Identical with ANTH 561)


564. *Introduction to Dendrochronology (4) Survey of dendrochronological theory and methods. Applications to archaeological, geological, and biological dating problems and paleoenvironmental reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 4L. Field trips. (Identical with ANTH 564 and WS M 564) Swetnam

567. Inverse Problems in Geophysics (3) I Linear and nonlinear inverse theory, including least squares, generalized and maximum likelihood methods. P. MATH 422b. (Identical with ATMO 567 and PTYS 567) Richardson

568. Advanced Seismology (3) II 1993-94 Computational techniques in seismology. The application of synthetic seismograms to model source processes and complex structure. P. 432/532; MATH 422b. Wallace


570. *Introduction to Paleocology (3) II Paleontologic approaches to the reconstruction of ancient environments, populations and communities. Evolution of communities through geologic time. 2R, 3L. Field trips. P. 225, 302. Flessa

571. Terrestrial Planets (3) I 1993-94 (Identical with PTYS 571)

573. *Geology and the Urban Environment (3) II Geologic processes that result in loss of life and/or property damage; emphasis on case studies of urban areas in the Southwest. Implications for public policy. 2R, 3L. All-day field trips. (Identical with PLNG 573) MacCallough

575. *Cenozoic Mammalian Faunas (3) II 1993-94 Study of mammal faunas and deposits yielding those faunas, with emphasis on sequential ordering of the faunas using biostratigraphic and paleomagnetic methods. 2R, 3L. Field trips. Lindsay

578. *Global Change (3) II Analysis of the entire Earth system through an examination of how its component parts and their interactions have changed in the past and may be expected to change in the future. P. Upper-division standing; introductory course work in biological and physical sciences. (Identical with ECOL 578, GEOG 578, HWR 578 and RNR 578) Graumlich

579. Introduction to Quaternary Macrofossil Analysis (4) [Rpt./1] II 1994-95 Literature and techniques of identification of plant remains including leaves, seeds, and wood of gymnosperms and angiosperms. 2R, 4L. Field trips. P. ECOL 472. O. Davis


581. Quaternary Palynology (4) II 1993-94 Theory and application of pollen to geology, biology, archaeology, and paleoecology; definition of information pollen sample record; experience in pollen extraction and identification. 2R, 4L. Field trips. P. 302. Cohen
y. Role of Water in Geologic Processes (1-4) [Rpt./6 units] II
z. Topics in Geophysics (1-4) [Rpt./6 units] II

597. Workshop
   c.* Dentrochronology (2) 3L (Identical with ANTH 597c and WS M 597c)
   *May be convened with 400-level course.


646a-646b. Advanced Ore Deposit Geology (4-4) Geology, characteristics and origins of ore deposits in igneous, sedimentary, and metamorphic rocks. Labs. include field trips, analytical techniques, problem solving. 2R, 6L. P, 446/546, CHEM 480a or CR. Titley/ Guilbert


651. Climatic Geomorphology (3) I 1994-95 Effects of climatic changes on geomorphic processes, landforms, and soils; paleoclimatic and earthquake-hazards interpretations. 2R, 3L. Field trips. Bull


German (GER)

Modern Languages Building, Room 571
(602) 621-7385

Professors David H. Chisholm, Max Dufner (Emeritus), Louis F. Helbig, Steven D. Martinson, Renate A. Schulz, David J. Woloshin (Emeritus) Associate Professors Roland Richter, Acting Head, Albrecht Classen, Dennis I. Greene (Emeritus), Babette Luz (Emerita)
Assistant Professors Barbara Kosta, Kamakshi P. Murti, C. Jane Rice, Mary Wildner-Bassett

The department offers a program leading to the Master of Arts degree with a major in German. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a teaching major in German. For information concerning this degree, see Requirements for Master's Degrees/Master of Education elsewhere in this catalog. Studies are available in the various areas of German language, literature, and culture in their more modern and contemporary aspects as well as in earlier historical and linguistic developments. Courses are also available in second language teaching methodology, applied linguistics, theory of second language acquisition and testing for a minor option in the M.A. degree in German.

Prerequisite for admission to the graduate program is the completion of at least sixteen acceptable units of upper-division, undergraduate course work in German.

Students working toward the Master of Arts degree must complete a minimum of 32 units of graduate work, including at least 24 units in courses offered by the Department of German. GER 601a and 601b are required of all master's candidates; GER 579 and 580 are required of all teaching assistants.

M.A. Thesis Option: Students may be permitted to write a thesis upon application to and consultation with the departmental Graduate Committee. Students approved for the thesis option must complete the twenty-four hour course work requirement (excluding 910). No more than six units may be earned for writing the thesis; thesis students enroll for GER 910, thesis.

The student must pass both a written and an oral comprehensive examination. Prior to this examination each student must either have passed 575a or 575b successfully or give evidence of an equivalent proficiency in the use of written German and must rate Superior on the ACTFL/ETS Oral Interview Test or an equivalent test.

500. Intensive Reading German for the Sciences and Humanities (4) S Rapid acquisition of reading proficiency in German. No prior knowledge of German is necessary. Proficiency certification obtained from this course fulfills graduate foreign language requirement in some departments (consult department for information). Credit for nonmajors only. Credit is not available for German majors.

501. Appropriating and Reshaping the Past (3) I 1994-95 Examines the creative reception of cultural artifacts found in oral traditions, religion, politics, historical events and the arts in German-speaking cultures. P. 6 units of upper-division German.

502. Genre as a Category for Organizing Experience (3) I 1993-94 Examination of individual texts in relation to theories of genre, with attention to shifting definitions of genre and resistance to generic categories. P. 6 units of upper-division German.

503. Erziehung und Bildung in German Culture (3) II 1993-94 Studies theories of education and their reflection in literary works. The Bildungsroman, for instance, discloses central elements of German culture and society. P. 6 units of upper-division German.

505.* History of the English Language (3) I II (Identical with ENGL 505)

506. Representing the Other (3) I II 1993-94 Explores narratives that construct the Other, the foreigner, and the outsider; discusses the politics of racism, sexism and exclusion using texts from various fields. P. 6 units of upper-division German.

507. Criticism and Creativity in German Culture (3) II 1994-95 Examines the relationship between theories of literature and literary practice, and the question of the nature of writing in general. P. 6 units of upper-division German.

509. Traditions and Modernism (3) I 1993-94 Provides a critical overview of literary and intellectual currents of the "modern" period; explores the changing status and social function of literature. P. 6 units of upper-division German.

510. Repression, Revolution, Revision (3) I 1994-95 Maps various movements and literatures that resist the repressing of history and stories. Focuses on narrative, memory and the construction of personal and national identities. P. 6 units of upper-division German.

511. Communication and Miscommunication in Middle High and Later German Literature (3) II 1994-95 Explores the way German writers have dealt with basic issues of human communication. P. 302b, 315b.

520. History of the German Language (3) II 1993-94 Examination of the semantic, socio-historical and structural development of German from the age of migrations to the present. P. 8 units of upper-division German. (Identical with ENGL 520)

525. Beowulf (3) II (Identical with ENGL 525, which is home)

527a. Studies in Medieval Language and Literature (3) (Identical with ENGL 527a)

555.* Music and German Literature (3) I 1993-94 The interrelationship between music and German literature from the 18th through the 20th century. Concentrates on major works of German drama, poetry and prose, and their musical settings. Lectures in English. Readings primarily in English, some German. P. 202. (Identical with MUS 555)

575a-575b.* Advanced Oral Expression and Written Composition (3-3) Practical training in written German through the study of the more complex refinements of German grammar and style, as found in representative documents. P. 315b. 575a is not prerequisite to 575b.

579.* Issues in Foreign Language Teaching (3) I Modern methods of language teaching with emphasis on German as a foreign language.

580.* Applied Linguistics for Foreign Language Teaching (3) II Issues in and methods of applied linguistics with emphasis on German languages.
587. Testing and Evaluation in Foreign/Second Language Programs (3) I Introduction to fundamental concepts, principles and problems of psychometric measurement relevant to FL/L2 learning. Types of tests and their uses, test construction, analysis and interpretation of results. (Identical with CLAS 586, FREN 586, ENGL 586, FREN 587, RUSS 586 and SPAN 587).

594. Practicum
a. Literature (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
b. L2 Acquisition and Teaching (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
c. Culture (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
d. Linguistics (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
e. Translation (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.

596. Seminar
a. Literature (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
b. L2 Acquisition and Teaching (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
c. Culture (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
d. Linguistics (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
e. Translation (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.

597. Workshop
a.* Literature (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
b. Pedagogy (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
c. Culture (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
d. Linguistics (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination.
e. Translation (1-5) [Rpt./5 units] I II P, competency at fourth year undergraduate level or pass departmental placement examination. *May be convened with 400-level course.

601a-601b. Approaches to German Studies (3-3) I II An overview of research materials, methods, theories and issues from which individual interests and concentrations in German studies can develop. Provides for the selection of faculty mentors.

587. Testing and Evaluation in Foreign/Second Language Programs (3) I Introduction to fundamental concepts, principles and problems of psychometric measurement relevant to FL/L2 learning. Types of tests and their uses, test construction, analysis and interpretation of results. (Identical with CLAS 586, FREN 586, ENGL 586, FREN 587, RUSS 586 and SPAN 587).

Gerontology (GERO)
800 East University Boulevard Suite 340
(602) 626-8104
Graduate Interdisciplinary Program in Gerontology
Committee:
Professors Carol Barnes (Psychology), Robert B. Bechtel (Psychology), John T. Boyer (Internal Medicine), Herbert E. Carter (Emeritus, Biochemistry), Roger M. Enoka (Exercise and Sport Sciences), Audrey L. Holland (Speech and Hearing Sciences), Theodore H. Koff (Public Administration and Policy), William A. Stini (Anthropology), Charles W. Weber (Nutrition and Food Science).
Associate Professors Patricia F. Fairchild (Exercise and Sports Sciences), Donna R. Iams (Family and Consumer Resources), Jessie V. Pergrin (Emerita, Nursing), Pamela G. Reed (Nursing), Stella Mae Smith (Special Education and Rehabilitation). Assistant Professors Iris R. Bell (Psychiatry), Christine M. Sheehy (Nursing).

Because of its multidisciplinary nature, study in gerontology is located in a number of departments. The Program on Gerontology plays a facilitating role in the coordination and development of aging studies and will guide students interested in incorporating a gerontological emphasis into their chosen field. Although no graduate major is offered, the program does offer a doctoral minor appropriate for students in areas such as education, administration, health, nutrition, and the social and behavioral sciences. A minimum of fifteen units selected from required and elective courses is required. It is also possible for students to pursue gerontological study in the Gerontology Certificate Program which offers formal recognition through an eighteen-unit structured course or graduate study. The program is similar to that of many other colleges and universities in this country and is designed primarily for individuals planning to enter or to continue in a profession which involves provision of services and/or administration of programs for the aging.

Students should consult with the major department about developing a gerontological emphasis within their major field through course work, research, thesis and dissertation. This most commonly occurs in the departments of Psychology, Speech and Hearing Sciences, Special Education and Rehabilitation, the School of Family and Consumer Resources, the School of Public Administration and Policy, and the colleges of Education, Nursing and Pharmacy. In addition, graduate work with a strong gerontological focus is available in human services administration (M.P.A.) and nursing/geriatric nurse practitioner (M.S.). Courses in other departments identified as having content which deals specifically with elderly and aging processes include: COU 570, 571; EXSS 566; FS 613, 636; ID 505; PA 524, 527, 593f; PSYC 521, 527; SER 515, 555, 584.

Further information on gerontology study and programs can be obtained from the coordinator at the address given above.

535. Adult Development and Aging (3) I (Identical with PSYC 535)
537. Gerontology: A Multidisciplinary Perspective (3) II (Identical with PSYC 537)
547. Perspectives in Geriatrics Laboratory (1) I II (Identical with PHPR 412)
548. Perspectives in Geriatrics (2) I II (Identical with PHPR 548)
557. Law of the Elderly (2) I II (Identical with MAP 557)
570. Human Adaptability (3) I (Identical with ANTH 570)
576. Communicative Aspects of Aging (2) I (Identical with SPH 576)
589. Health of the Older Adult (3) I (Identical with NURS 589)
*May be convened with 400-level course.
613. Issues in Aging (3) I II (Identical with F S 613)
636. Economics of Aging (3) I I (Identical with FS 636)
695. Colloquium
a. Research in Gerontology (1) I II (Identical with PHPR 695a)

Greek
(See Classics)

Graduate Interdisciplinary Programs
1010 N. Martin Avenue
(602) 621-8368
Graduate interdisciplinary programs are offered by the following committees:
American Indian Studies
Applied Mathematics
Arid Lands Resource Sciences
Cancer Biology
For course offerings in these programs, refer to the specific program in the Departments and Courses of Instruction section of this catalog.

Italian
(See French and Italian)

Japanese
(See East Asian Studies)

Health-Related Professions (HLTH/OSH/EXSS/MEDT)

Anne E. Atwater, Interim Director

The School of Health-Related Professions offers programs leading to the Master of Arts and Master of Science degrees with a major in exercise and sport sciences. A minor in exercise and sport sciences is available for doctoral students with majors in other disciplines. Students may specialize in exercise physiology at the Ph.D. level by majoring in physiological sciences (see that entry elsewhere in this catalog), an interdisciplinary major that incorporates faculty from several departments and colleges within the University.

All applicants must submit scores in the General Test of the Graduate Record Examination, a statement of professional goals, and three letters of recommendation from persons in a position to evaluate the applicant's potential as a graduate student.

The purpose of these graduate programs is to prepare individuals for careers in exercise science, research and teaching. Recognizing that most students wish to specialize in their graduate work, it is necessary to insure some breadth of knowledge is obtained in the exercise and sport sciences. Students are permitted to use graduate or undergraduate courses for satisfaction of any perceived deficiencies.

Community and Environmental Health

1435 N. Fremont Ave., Room 111
(602) 882-5852

Associate Professors Richard L. Papenfuss, Head, Kam Nasser
Assistant Professors Clifton D. Crutchfield, Scott J. Leischow, Mark D. Van Ert

Health Education (HLTH)

530.* Theory-based Approaches in Health Education/Health Promotion (3) I Analysis of the epidemiological data to determine the health problems of our people; behavioral relationships; and the application of theory-based educational strategies designed to prevent health problems.

532.* Program Planning and Education in Health Education/Health Promotion (3) II Principles for planning, implementing, administering and evaluating health education programs utilizing the "PRECEDE Model" as a framework.

535 Multicultural Health Beliefs (3) II Designed to provide a sensitivity to health promotion professionals to the varying multicultural health beliefs and needs of our society. Special emphasis on ethnic characteristics of minority populations in Arizona with recommendations for programming strategies.

540.* Survey of Health Education/Health Promotion Literature (3) I Examination of health education/promotion literature from ancient societies to present, including an analysis of current health literature from various professional, community, voluntary, public and international health organizations.

Occupational Safety and Health (OSH)

502.* Industrial Hygiene Instrumentation and Analysis (2-4) I Introduction to field sampling instruments and strategies, quality control, and statistical analysis, with emphasis on instrument selection and calibration. 2R, 3L. P, 586. (Identical with TOX 502)

510.* Physical Exposures (3) II Recognition, evaluation, and control of physical exposures, including radiation, noise, vibration, and heat stress. Students is required to recognize potential exposures, use correct instrumentation to collect and evaluate data, and develop controls. 2R, 3L. P, 486. (Identical with TOX 510)

512.* Hazardous Materials (2-4) I Recognition, evaluation, and control of exposure to environmental and industrial air contaminants. P, 586. (Identical with TOX 512)

586.* Fundamentals of Industrial Hygiene (3) I Introduction to the principles of occupational safety and health, with emphasis on industrial hygiene aspects including recognition, evaluation, and control of environmental and industrial health hazards. (Identical with GE 586 and TOX 586)

587.* Advanced Industrial Hygiene and Safety (3) II An in-depth coverage of the industrial hygiene and safety professions emphasizing the principles of contaminant behavior and the design of industrial hygiene/safety programs. P, 486. (Identical with CE 587 and TOX 587)

*May be converted with 400-level course.

Exercise and Sport Sciences (EXSS)

Ina E. Gittings Building, Room 101
(602) 621-6989

Professors Anne E. Atwater, Acting Head, Roger M. Enoka, Timothy G. Lohman, Donna Mae Miller (Emerita), Frederick B. Roby, Mary P. Roby (Emerita), Charles M. Tipton, Jean M. Williams

Associate Professors Boyd B. Baker, William K. Coopwood (Emeritus), Gary D. Delforge, Patricia C. Fairchild, Bruce A. Larson, Richard A. Munro, (Emeritus), Kathryn R.E. Russell, Darrell G. Stucky

Assistant Professors Ralph F. Fregosi, Kim C. Gruber, Erik J. Henriksen, Kevin C. Kregel

Study programs for both the Master of Arts and Master of Science degrees are individually planned, in consultation with an advisor, around a principal area of interest. The Department of Exercise and Sport Sciences offers two options for the major, one that is clinical in nature and the other that is thematic (individualized). Clinical exercise science includes three specializations: athletic training, stress management and wellness, and sports science. The thematic option permits students to develop a study plan that builds on the student's background, special interests and future goals. In consultation with an advisor, students are able to develop a program that may encompass the more traditional areas of study or they can develop totally new ones.

Students should have an undergraduate academic background which supports their interest area(s) at the graduate level. For example, some specializations/study plans require an undergraduate science background that includes anatomy, physiology, chemistry, and similar subjects, while others do not.

Master's degree candidates may select one of three plans: (1) a thesis option which requires 30 units including preparation of a thesis for which 6 units may be earned, or (2) a non-thesis option which requires completion of 32 to 36 units, depending on the program of
physiological mechanisms. P, CHEM 103a-103b, 104a-104b, EXSS 201, 202, MATH 117R/5, 118. Fregosi

521. *Exercise Physiology Laboratory (2) I P, CR, 520


527. Psychology of Sport and Exercise (3) I Examines the effects of motivation, personality, attitudes, competition, and group dynamics on sport performance as well as the psychological effects of exercise, exercise adherence, and exercise addiction. Williams

528. Stress Management for Performance and Health (3) I Examines within a biopsychosocial framework the concept of stress as it relates to performance and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams

529. Psychological Interventions and Ergonomic Aids for Peak Performance (3) II The application and effectiveness of ergonomic aid mechanisms, particularly psychological interventions, in enhancing performance. P, 528. Williams

536. Administration of Sports Programs (3) I Designed to provide a theoretical framework for students pursuing sports management careers and others interested in various functions involved in the conduct of sport programs. Baker

545. *Evaluation and Regulation of Body Build and Composition (3) I Laboratory and field assessment of body fat, lean body mass and somatotype; anthropometry; body build and composition of the athlete; morphology of fat and lean tissue; exercise and dietary regulation of obesity and chronic underweight. P, 201, 202.

560. *Biomechanics of Human Movement (3) II Analysis of human motion focusing on the mechanical interaction between the human body and the external environment. 2R, 3L, P, 201, 202, 462. Attwater/Enoka


565. Physical Activity in Aging and Chronic Diseases: Physiological Aspects (3) III The etiology and pathophysiological processes involved in coronary heart disease, hypertension, diabetes, and aging; role of exercise in prevention as a potential therapeutic intervention. P, 520

566. Physical Activity in Aging and Chronic Diseases: Psychosocial Aspects (3) I Psychosocial dimensions of exercise programs designed for populations with chronic diseases as well as for older populations. Fairchild

570. Research Design in Exercise and Sport Sciences (2) I Study of research designs, methodologies and data analysis procedures pertinent to the exercise and sport sciences; emphasis is on the selection of research problems and interpretation of research articles. Lohman

571. Laboratory in Research Design for Exercise and Sport Sciences (1) I Laboratory experiences in literature retrieval systems; data analysis procedures by calculator, microcomputer, and mainframe computer; critical analysis procedures of research articles, and participation in a research project. CR 570. Lohman

573. Statistical Analysis (3) II Analysis of research designs and data analysis procedures in the field of exercise and sport sciences with emphasis on appropriateness of selected designs and interpretation of various data analysis procedures. Statistical power, reliability, covariance and multiple regression techniques and uses of micro- and mainframe data analysis software. P, 570 and 571. Lohman

580. Evaluation of Athletic Injuries (3) I Advanced study of the etiology, pathology, and clinical signs of common athletic injuries. Emphasis on clinical evaluation of athletic injuries by the athletic trainer. P, 377; 800 hours of clinical experience in athletic training. Delforge

581. Therapeutic Modalities (2) II Advanced study of the role of hydrotherapeutic and electrotherapeutic agents in the rehabilitation of athletic injuries. P, 580

582. Anatomical Basis of Sport Injuries (3) I Comprehensive survey of bones, ligaments, muscles, nerves, and vessels of the trunk and upper and lower extremities, with emphasis on their relationship to sporting injury. 2R, 3L, P, CR 580


584. Rehabilitation of Athletic Injuries (3) II Principles in the planning and implementation of rehabilitation programs for injured athletes with emphasis on application of contemporary therapeutic exercise techniques. P. 580. Delforge

585. Issues in Athletic Training and Sports Medicine (3) II Current issues and trends in athletic training and sports medicine with emphasis on the professional preparation of athletic trainers and the role of the certified athletic trainer in athletic health care delivery systems. P. 580. Delforge

586. Physical Education and the Law (3) I Investigation and analysis of legal parameters within which the physical educator and coach operate; negligence theory; common defenses; product liability; insurance; legal implications for program development and methodology. Baker

588. Legal Aspects of Sports Administration (3) II Development of administrative and coaching techniques from the legal perspective. Analysis of personnel procedures, purchase of equipment, athletic associations, certification, transportation, medical procedures, officiating, and the handicapped athlete as influenced by litigation. P. 586. Baker

593. Internship a. Sports Medicine (2) I P, 581, 584. b. Psychology (1-3) [Rpt./6 units] I II S, 528 or 529.

595. Colloquium a.* Research in Exercise Sciences (1-2) [Rpt./3 units] I II Open to majors only. b.* Biomechanics (2) [Rpt./1] I P, 460 or 462. c. Current Issues in Space Physiology (2) [Rpt./1] I P, 520.

d.* Environmental Physiology (2) [Rpt/1] II P, 520.

e.* Endocrinology and Metabolism (2) [Rpt./1] II P, 520.

f.* Integrative Cardiorespiratory Physiology (2) [Rpt./1] I P, 520

596. Seminar a. Introduction to Microcomputers (1) I II Attwater

*May be counted with 400-level course.

691. Preceptorship a. Laboratory Rotations (1-3) I II S 3-9L. Open to majors only. P, 570, 571.

695. Colloquium a. Motor Control (2) [Rpt./8 units] I I P, PSIO 480 and consult department before enrollment. (Identical with NEUR 695a, PSIO 695a, PSYC 695a, SP H 695a)

793. Internship a. Sport Psychology (1-3) [Rpt./12 units] I II S P, 528 or 529.

Medical Technology (MEDT)

1435 N. Fremont Avenue, Room 124 (602) 626-4084

Although no graduate degree programs, are offered by the Division of Medical Technology, the graduate courses listed below are available to graduate students enrolled in related programs such as microbiology and chemistry.

571. *Lectures in Clinical Hematology (5) [Rpt./1] II Lectures in basic hematology and hematological procedures including cell struc-
ture and function, inherited and acquired anomalies, hemostasis, cell enumeration and differentiation, cytogenetics. P, consult program director before enrolling.

571L.* Fundamental Laboratory Techniques in Clinical Hematology (2) [Rpt./1] II Basic laboratory techniques in clinical hematology with emphasis on manual and automated hematological procedures. Instruction includes proper procedural methodologies, quality control, the use of controls and standards, and interpretation of laboratory test results. P, CR, 471R/571R, consult program director before enrolling.

572L.* Lectures in Clinical Immunology and Immunohematology (4) [Rpt./1] I Lectures in serological methods used in the clinical laboratory and interpretation of results; blood banking procedures. P, consult program director before enrolling.

573L.* Lectures in Clinical Chemistry (5) [Rpt./1] II Lectures encompassing the fundamental concepts of clinical laboratory chemistry including pathophysiology and clinical correlations. P, consult program director before enrolling.

574L.* Lectures in Clinical Bacteriology (5) [Rpt./1] I Lectures relating to laboratory techniques used to safely isolate and identify pathogenic bacteria. Special media/tests, or treatment techniques in clinical bacteriology. P, consult program director before enrolling.

575L.* Topics in Clinical Microbiology (2-3) [Rpt./1] II 575a: Clinical Parasitology. Diagnostic methodologies with emphasis on the laboratory identification of clinically relevant parasites. 575c: Clinical Mycology and Mycobacteriology. Diagnostic methodologies with emphasis on the laboratory identification of clinically relevant fungi and Mycobac-

576.* Principles of Laboratory Science (3) [Rpt./1] II Basic principles of laboratory mathematics, biostatistics, body fluids analysis, urinalysis, quality control and laboratory safety. P, consult program director before enrolling.


*May be convened with 400-level course.

History and Philosophy of Science (HPSC)

Social Sciences Building, Room 213
(602) 621-3120

Graduate Interdisciplinary Program in History and Philosophy of Science

Committee:
Professors Henry C. Byerly (Philo-

sophy), Chair, Robert M. Harnish (Philos-

ophy and Linguistics), William A.

Longacre (Anthropology), Richard E.

Michod (Ecology and Evolutionary Bi-

ology)

History of science deals with the origins and development of science as an activity which seeks understanding of our universe. Philosophy of science deals with the logical analysis of scientific reasoning, the clarification of fundamental scientific concepts, and methodological problems common to many fields of scientific inquiry.

The committee offers a Doctor of Philos-

ophy minor in history and philosophy of science. Its interdisciplinary nature makes it useful as a supplement to the

doctoral work of students in the sciences who are interested in foundational or methodological issues, as well as to students of philosophy or history.

History (HIST)

Social Sciences Building, Room 215
(602) 621-1586

Professors Michael Schaller, Head, Herman E. Bateman (Emeritus), Gail Bernstein, Robert P. Browder (Emeritus), Paul A. Carter (Emeritus), Richard A. Cosgrove, Leonard Diner- 

stein, James Donohoe (Emeritus), Donna J. Guy, Harwood Hinton (Emeritus), Ursula Lamb (Emeritus), Oscar Martinez, John V. Mering (Emeritus), Michael C. Meyer, Roger L. Nicho-

l, Heiko A. Oberman, J. Gregory Oswald (Emeritus), Thomas W. Parker (Emeritus), Robert Vignery, Donald Weinstein (Emeritus)


Assistant Professors Bert Barickman, John Campbell, Linda Darling, Maureen Fitzgerald, Alison Futrell, Nancy Hunt, Patrick Miller, James Millward, Katherine Morrissey, Laura Tabli

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in history. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in history.

Applicants for the graduate program must have completed the equivalent of the bachelor's degree with a major in history or related subject and are required to submit scores on the aptitude tests of the Graduate Record Examination, a statement of purpose, and three letters of recommendation. All Ph.D. students must participate in a formal review of their program during the first year of doctoral studies.

Degrees

Master of Arts: At least 24 units must be completed in history including 21 units in one of the following areas: Ancient Europe, 800-1648; Europe, since 1648; Latin America; United States; Asian His-

H. The student who elects to submit a thesis for six units will receive thesis credit for six units and will be required to
complete at least twelve additional units at the 695-696 level in history. The student who elects to present two research seminar papers (six units) in lieu of thesis is required to complete at least eighteen units at the 695-696 level in history. Each student must demonstrate reading knowledge of one foreign language. In special cases computer programming or statistics may be substituted for the foreign language requirement. Each student must pass a final examination covering one of the two areas selected for concentration. A total of 30 units is required for the degree.

Master of Education: All students must complete at least eighteen units in history, not fewer than six of which are at the 695 level or above. An oral or written examination covering the work in history as well as an examination by the College of Education must be passed, but no thesis is required. For further information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Doctor of Philosophy: In consultation with an advisor, each beginning student will select primary and secondary areas of concentration within the history major. Each student must demonstrate a reading knowledge of two foreign languages. In United States history, a reading knowledge of one foreign language and possibly other skills will be required. Preliminary to admission to formal candidacy, each student must pass an examination covering the fields chosen. Following this examination, the candidate must prepare and defend a dissertation displaying mature research in original sources, competence in assembling and presenting historical data, and critical scholarship. Primary areas of concentration: ancient history; Europe, 800-1648; Europe, since 1648; Latin America; United States. Secondary areas of concentration: Any primary area of concentration other than the chosen one; an approved minor in another department; or Asian history; comparative women's history; history of religion.

501. * Ancient Mesopotamia (3) I (Identical with ANTH 501)

504a-504b. * History of Rome (3-3) 504a: The Republic to the death of Caesar. 504b: The Empire through the reign of Constantine the Great. 504a is not prerequisite to 504b.

505a-505b. * Medieval Europe (3-3) Major institutions and trends in Europe from the breakup of the Roman World to the 14th century. 505a is not prerequisite to 505b. P, 3 units of lower-division European history.

506. * Medieval England (3) II From the Norman conquest to the Hundred Years War, with emphasis on political, social, and cultural developments. P, 3 units of lower-division European history.


508. * The Renaissance (3) I Europe between the 14th and 16th centuries with special emphasis on Italy as the seat of the Renaissance. Topics include the city states, humanism, the Church in an age of Schism and secularization, Renaissance art, the New Monarchies and European exploration and imperialism. P, 3 units of lower division European history.

509. * The Reformation (3) II The Reformation in thought and action both from the perspective of its religious origins and of the political and social conditions. Analysis of its impact on sixteenth century Europe including the spread of Protestant reformation and its companion movement, counter-reformation.

510. * History of Hell in Early Europe (3) I The concept of punishment after death in Western Europe from the Bible to Dante. Includes the Hebrew, Greco-Roman, Germanic, and Christian traditions. P, 3 units of European history.

511. * European Social and Intellectual History to 1750 (3) I Dominant themes in European intellectual history from the end of the Middle Ages to the period of the Enlightenment. Reading and discussions of texts from Petrarch to Locke. P, 3 units of any history course.

512. * European Intellectual History: 1750 to 20th Century (3) II Dominant themes in European intellectual history from about 1750 to the 20th century. Reading and discussions of texts from David Hume to Friedrich Nietzsche. P, 3 units of any history course.

513. * War and Peace in Europe (3) II European background to contemporary international relations from the Congress of Vienna through the outbreak of World War II.

514. * Cultural History of Germany to 1714 (3) I The political, social, economic and cultural history of Germany from the middle Ages to the period of the Enlightenment. P, 3 units of any history course.

515. * Cultural History of Germany 1714 to 1869 (3) II The political, social, economic and cultural history of Germany from the period of the French Revolution to the present. P, 3 units of any history course.

516. * Tudor-Stuart England (3) I An intensive study of English history from the accession of Edward IV to the Hanoverian dynasty.

517. * History of Modern Britain (3) II An intensive study of English history from the accession of George III to the present.

518. * France under the Old Regime, 1589-1789 (3) I French political development, institutions, and culture from Henry IV to the eve of the French Revolution.

519. * The French Enlightenment (3) I Cultural history of France in the 18th century, with emphasis on the works of the philosophers.

520. * The French Revolution and Napoleonic (3) II The origins and progress of the Revolution in France.

521. * History of Russia: Early Period (3) I Political, socio-economic, and cultural history of Russia in medieval and early modern times.

522. * History of Russia: Modern Period (3) II Political, socio-economic, and cultural history of Russia in the modern era until the Bolshevik Revolution.

523. * Intellectual History of Russia (3) II The historical significance of social, political, and revolutionary thought in 19th- and 20th-century Russia. P, 3 units of any history course.

524. * The Russian Revolutions (3) I The era of reform and revolutions in Russia from 1890 to 1921, culminating in the formation of the Soviet regime. P, 3 units of any history course.

525. * History of the Soviet Union (3) I The Bolshevik Revolution and problems of Soviet Russian history from 1917 to the present. P, 3 units of any history course.

531. * Colonial America (3) I The experience and evolving institutions of the North Atlantic colonists from the first landings to the end of the French and Indian War. P, 3 units of any U.S. history survey course.


534. * Jacksonian Era, 1828-1856 (3) I Political, economic and social developments from the "reign" of Andrew Jackson through the collapse of the Whig Party in the 1850s. P, 3 units of any U.S. history course.

535. * The Coming of the Civil War, U.S. 1845-1861 (3) I Political, constitutional, social and economic developments in the U.S. from the Mexican War through the Civil War.

536. * Civil War and Reconstruction, U.S. 1861-1879 (3) II Political, constitutional, economic, and military developments in the U.S. and the Confederacy during and after the Civil War.

537. * U.S. 1876-1919 (3) I The Gilded Age and Progressive Era (3) Examination of economic, social, and political developments in the years of rapid industrialization from the end of Reconstruction through World War I. P, 3 units of any history course.

538. * U.S. 1918-1945 From World War I through World War II (3) III Prosperity, Depression and the New Deal in peace and war.

540. * United States: 1945 to Present (3) III American society and the role of the United
States in world affairs from the Yalta Confer-ence to the present. P, 3 units of any his-

tory course.

542. * History of American Society and Thought: Pre-Civil War (3) I American polit-
cal, religious, cultural and philosophical ideas as expressed in colonial, revolutionary, and pre-Civil War society.

543. * History of American Society and Thought Since the Civil War (3) II The trans-
formation of American minds since the Civil War as expressed in literary, philosophic, reli-
gious, and other cultural forms.

546. * History of Arizona (3) I II Economic, social, and political development of the state from Spanish times to present.

548. * History of American Foreign Relations to 1914 (3) I Examines the rise of America from a struggling colony to a world class power, including its relations with Europe, Latin America and Asia. P, 3 units of any his-
tory course.

550. * History of American Foreign Relations Since 1914 (3) II Examines the pivotal role played by the United States in world affairs since WWI, focusing on America's struggle with revolutionary movements in Europe, Asia and Latin America. P, 3 units of any his-
tory course.

551. * The United States and East Asia: 1840 to the Present (3) II An examination of American interaction with Japan and China since the Opium Wars, with special attention given to economic, cultural, and military relations and conflicts. P, 3 units of any history course. (Identical with EAS 551)

552. * American Ethnic History (3) II A his-
tory of the various ethnic minorities in Amer-
ica from Colonial times to the present, with emphasis on adjustment, accultur-ation and degrees of assimilation. P, 3 units of any history course.

553. * History of Women and Work (3) I II History of women and work in western and non-
western nations from prehistoric times to the present. P, 3 units of any history or women's studies course.

556. * Central America: From Colonialism to Revolution (3) II Social, economic, and politi-
cal history of Central America from colonial period to the present focusing on the origins of contemporary crisis. (Identical with LAS 556)

557. * The Mexican Revolution (3) S A de-
tailed examination of Mexico's social upheaval of 1910, and its implications for contemporary Mexican society. Offered in Guadalajara only.

558. * Feminism: A Comparative History (3) II International history of feminism as an ide-
ology and a political movement from the 17th century to the present. P, 3 units of any his-
tory or women's studies course.

559. History of Books and Printing (3) I (Identical with LI 559)

561. * The Ethnohistory of Mesoamerica and the Andes (3) II 1994-95 The impact of con-
quest and Spanish rule on the native peoples of Mexico, Central America, Peru, Bolivia, and Ecuador. Topics include: conquest and ecol-
ogy; land and labor; religion and culture; ad-
aptation and resistance. 2R, 1D.

563. * Asian Marxism (3) II (Identical with EAS 563)

564. * History of Argentina (3) I Survey of Ar-
tegine history and culture from the colonial era to the present. P, 3 units of any lower-
division Latin American history course. (Identical with LAS 564)

566. * History of Brazil (3) II History of Brazil from 1500 to the present. (Identical with LAS 566)

567. * Contemporary Latin America (3) I Re-
solution, social change and reaction in Latin America from 1930 to the present. (Identical with LAS 567)

568a-568b. * Asia and the West (3-3) Processes of interaction between Europeans and the peoples and cultures of the Middle East, South Asia, and East Asia, from the Portu-
guese explorations to the present. (Identical with NES 568a-568b)

569. * History of Women in Latin America (3) II Women's history in Latin America from the Conquest to the present. P, 3 units of any lower-division Latin American history or women's studies course. (Identical with LAS 569)

570. * Religious History of India (3) Devel-
opment of major religious traditions of South Asia: Vedic Religion, Buddhism, Jainism, Hinduism, Sikhism, and Islam. (Identical with NES 570)

572. * History of Medieval India (3) I Survey of Indian history from the 7th century to 1750. (Identical with NES 572)

573. * History of Modern India and Pakistan: 1750-Present (3) II Survey of political, social and economic developments in South Asia from the mid-18th century to the present. (Identical with NES 573)

574a-574b-574c. * History of Japan (3-3-3) So-
cial, cultural, economic and political history of Japan. 574a: From earliest times to 1500. 574b: 1500-1800. 574c: 1800-present. (Identical with JPN 574a-574b-574c). P, 3 units of any history, Chinese, Japanese or East Asian studies course.

575a-575b-575c-575d-575e. * Periods in Chi-
nese History (3-3-3-3-3) (Identical with CHN 575a-575b-575c-575d-575e)

576. * Modern Chinese History (3) (Identical with CHN 576)

577a-577b. * History of the Middle East (3-3) (Identical with NES 577a-577b)

578. * Modern History of the Middle East (3) I (Identical with NES 578)

579. * The Ottoman Empire to 1800 (3) II 1993-94 History of Ottoman Empire from its origins through the direct Western European impact, focusing on the political and social history of the empire in Europe and Asia.

581. * Work, Motherhood and Female Iden-
tity in America: 1945 to the Present (3) I (Identical with W S 581)

582. * Social History of China (3) (Identical with CHN 582)

583. * Gender and African History (3) I II S The history of men, women, gender relations, and gender meanings in sub-Saharan Africa. The importance of gender analysis, both socio-
ological and symbolic, to understanding Af-
rican history. P, 3 units of history or consent of instructor. (Identical with WS 583)

588. * History of Byzantium (3) II Political, so-
cial, and cultural history of Byzantium from A.D. 325 to 1453, including the Byzantine legacy in Europe and the Middle East. (Identi-
cal with CLAS 588)

589. * Women in East Asia (3) I Women in tradi-
tional China and Japan; analysis of changes occurring in the modern period. (Identical with EAS 589)

590. * Philosophy of History (3) I Introduction to historical thinking from antiquity to the present, with emphasis on ideas in European and North American historical writings during the modern and contemporary eras.

592. * History of Sufism (3) II Origin and de-
velopment of Sufism and its impact on the Muslim and non-Muslim worlds. (Identical with NES 592)

595. Colloquium Certain colloquia in other departments may be used for history graduate credit.

596. Seminar m.Mexican-American Heritage Bibliog-
raphy—A Library Seminar (3) [Rpt./6 units] I (Identical with MAS 596m, which is home)

597. Colloquium *May be conferred with 400-level course.

598. Colloquium a. Advanced Studies in United States His-
tory (3) [Rpt./10] I II

b. Advanced Studies in Latin American History (3) [Rpt./10] I II (Identical with LAS 695b)

c. Advanced Studies in European History (3) [Rpt./10] I II

e. Advanced Studies in the History of Women (3) [Rpt./10] I II (Identical with WS 695b)
f. Advanced Studies in Ancient History (3) [Rpt./10] II Consult department before enrolling. (Identical with CLAS 695c)

599. History of Byzantium (3) II Political, so-
cial, and cultural history of Byzantium from A.D. 325 to 1453, including the Byzantine legacy in Europe and the Middle East. (Identi-
cal with CLAS 588)

600. Seminar Certain seminars in other departments may be used for history graduate credit.

601. Seminar a. Colonial U. S. History (3) [Rpt./10] I II

b. Nineteenth-Century U. S. History (3) [Rpt./10] I II

c. Twentieth-Century U. S. History (3) [Rpt./10] I II

d. Ancient History (3) [Rpt./10] I

e. Medieval Europe (3) [Rpt./10] I II

f. Early Modern Europe (3) [Rpt./10] II P; Latin and German required.

g. Eighteenth-Century Europe (3) [Rpt./10] I II
Hydrology and Water Resources (HWR)

Geology Building, Room 122
(602) 621-5082

Professors Sorooch Sorooshian, Head (Systems and Industrial Engineering), Nathan Buras, Dinshaw Contractor (Civil Engineering), Donald R. Davis, Stanley N. Davis (Emeritus), Robert E. Dickinson (Atmospheric Physics, Tree Ring Lab), Lucien Duckstein (Systems and Industrial Engineering), Daniel D. Evans (Emeritus), Martin M. Fogel (Emeritus), Martha Gilliland, Richard H. Hawkins (Watershed Management), Simon Ince (Civil Engineering), Helen Ingram (Political Science), Charles W. Kreitler, Austin Long (Geosciences), William B. Lord (Agricultural and Resource Economics), Thomas Maddock III, Shlomo P. Neuman, William J. Shuttleworth, Eugene S. Simpson (Emeritus), Ernest T. Smerdon (Civil Engineering)

Associate Professors Roger C. Bales, Randy L. Bassett, Michael D. Bradley, Bonnie Colby (Agricultural and Resource Economics), Katherine Hirschboeck (Tree Ring Lab), T.-C. Jim Yeh

Assistant Professors Marc Brusseau (Soil and Water Science), Martha H. Conklin, Kevin Lansey (Civil Engineering)

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in hydrology and in water resources administration. The faculty offers competence in hydrogeology, hydrochemistry, hydrometeorology/hydroclimatology, environmental hydrology, groundwater hydrology, surface-water hydrology, mathematical and statistical methods in hydrology (including numerical modeling), and in water resource planning, management, and administration.

Applicants need not have completed an undergraduate major in hydrology; however, previous study in a closely related field is prerequisite. The programs have been developed to enable graduates from the basic sciences and from related fields, such as geology, engineering, agriculture, meteorology, economics, and political science, to enter directly. Applicants should submit Graduate Record Examination scores (general test only), a statement of purpose or career objective, and three letters of recommendation.

Graduate study programs are individually planned to meet the student's special interests and professional objectives. Certain basic courses in hydrology and water resources are required of each master's candidate unless equivalent courses were taken elsewhere. All students are expected to acquire a capability for computer programming.

Applicants for admission to the Doctor of Philosophy degree program should have completed the Master of Science degree with a major in hydrology, water resources, environmental sciences, environmental engineering, or a related field. Where gaps exist in background knowledge of relevant subject matter, the student may be required to take additional course work.

Majors

Hydrology: The program is designed for students with special interest in the physical, chemical, and biological aspects of the hydrologic cycle as it relates to water resources. Students may concentrate in one or in a combination of these fields but should acquire some proficiency in all aspects of hydrology and water resources administration.

Water Resources Administration: This program is for students with special interests in operations research, management, environmental studies, or the social sciences as related to water resources. Students majoring in the program are expected to have or acquire a basic knowledge in hydrology. Three areas of concentration are currently defined: water policy and planning, water resources systems, and environmental and water quality management.

500. Ecosystemology for Urban Planning (3) I Introduction to conceptual tools used in complex ecosystems, particularly cities and urban areas; introduction of human residents with larger natural systems (human ecology); environmental impact assessment (EIA) and statement (EIS). Water resource planning and impact on regional ecosystems; technical, legal, ethical dimensions of water transfer. (Identical with PLNG 500) Bradley

503. Subsurface Fluid Dynamics (3) I Dynamics of immiscible fluids in porous and fractured media; anisotropy and scale; advective solute transport; consolidation and land subsidence; multi-aquifer systems; free surface flow and salt water/freshwater interfaces. P, MATH 223 or (preferably) 322 or 422 or 422b, C E 321 or AM E 331a. (Identical with C E 503) Neuman

504. Numerical Methods in Subsurface Hydrology (4) II Finite difference, finite element and boundary integral methods for subsurface fluid flow and mass transport; applications to aquifers, unsaturated soils, seepage through earth structures. P, MATH 422a or consult department before enrolling. (Identical with C E 504) Neuman

505. Vadose Zone Hydrology (3) II Fundamentals of multiphase flow and transport in the vadose zone. Methods for characterization of hydraulic properties and mathematical solutions for particular cases. P, 407 or 503 or 518 or 5 W 470.

506. Water Quality Dynamics (3) II Chemical and physical methods are used to study the quality of ground and surface waters with emphasis on organic contaminants, colloids, and surface processes including sorption phenomena. Equilibrium and dynamic models of water chemistry. P, 517R-517L. Conklin

508.* Vadose Zone Monitoring (3) II 1994-95 Laboratory and field methods for characterizing water flow and contaminant transport through saturated geologic media. 6L, P, 407 or 503 or 518 or 5 or S 470.


514. Field Hydrology (Surface Water) (1) S Field methods of collection, compilation, and interpretation of data in surface water. Stream gaging, hydrography and limnology exercises; evaporation studies; slope-area method of indirect discharge measurement; flood-plain mapping. Daily field work. Fee. P, 519. Ince

515.* Introduction to Water Resources Policy (3) II Water resources policy including the identification of regional problems of water use, the elements of water planning, water rights, and a consideration of institutional structures and processes. P, MATH 125a. (Identical with GEOG 515) Bradley

516. Hydrologic Transport Processes (3) I Development and application of equations describing mass and energy transport in subsurface environment. P, 503 or 535, SIE 270. Yeh

517. Fundamentals of Water Quality (3) I Introduction to chemical processes affecting the behavior of major and minor chemical species in the aquatic environment. Physical, equilibrium, organic, and analytical principles as applied to natural waters. 517R may be taken in conjunction with or independent of 517L; however, 517R is prerequisite to 517L. P, CHEM 103b, PHYS 136, and MATH 125b; or, P, MATH 254. Bales/Bassett/Conklin

517L. Fundamentals of Water Quality Laboratory (1) I Field and laboratory methods in water quality sampling and analyses. Includes both wet chemical and instrumental methods
696. Seminar
b. Unsaturated Flow (1-3) II

c. Ground-Water Management Modeling (1-3) I II; consent of instructor.
ed. Pollutants in the Hydrologic Environment (1-3) III
f. Advanced Hydrologic Modeling (1-3) II
i. International Water Resource Management (1-3) [Rpt./2] I (Identical with POL 696, NRES 696)
j. Water Quality Planning and Policy (1-2) II
k. Science and Technology of Radioactive Waste Management (1-3) [Rpt./1] II
m. Operations Research Methods to Water Resources Systems (1-3) [Rpt./1] II P, consult department before enrolling. (Identical with SIE 696m)
q. Advanced Methods in Hydrometeorology/Hydroclimatology (1-3) I II

697. Workshop
a. Interdisciplinary Problem Solving in Natural Resources I (2) II 697a/697b is part of a two-semester sequence. Credit and grade for 697a will be awarded only upon completion of 697b. P, consult department before enrolling. (Identical with RNR 697a) Lord/Maddock
b. Interdisciplinary Problem Solving in Natural Resources II (2) II 697a/697b is part of a two-semester sequence. Credit and grade for 697a will be awarded only upon completion of 697b. P, consult department before enrolling. (Identical with RNR 697b) Lord/Maddock

Industrial Engineering
(See Systems and Industrial Engineering)

Journalism (JOUR)
Franklin Building, Room 101M (602) 621-7556

Professors Donald W. Carson, Philip Mangelsdorf (Emeritus), George W. Ridge, Jr., Jacqueline E. Sharkey

Associate Professors Jim Patten, Head, Ford N. Burkhart, William F. Greer, James W. Johnson
Assistant Professor Virginia Escalante

The department offers a program leading to the Master of Arts degree with a major in journalism. The program is designed for students dedicated to developing or improving professional skills while attaining an academic background in one or more specializations.

An undergraduate major in journalism is not necessary for admission. Students are required to complete 205, 206, and 320 as deficiencies without graduate credit.

A minimum of thirty units is required for the master's degree. Electives are chosen from journalism or related fields with the approval of the adviser. A complete program of study must be approved by the graduate adviser in the first semester, and the adviser must approve any subsequent changes. No foreign language proficiency is required, although for those interested in Latin America, the department has an exchange program in Guadalajara.

Students are required to work on one departmental newspaper and to demonstrate a high level of skill in reporting and writing courses. The program of study must include 511, 513, 502, 570 or 593a, and 909. Advanced-degree credit will not be given for a grade lower than "B" in any professional, photojournalism, or editing course.

The graduate program has been accredited by the American Council for Education in Journalism and Mass Communications.

502. Freedom of Expression (3) II Analysis of access and barriers to information and communication at local, state, national and international levels; intensive study of the legal relationship between mass media and society. Open to majors only.

503.* Advanced Photojournalism (3) II Reporting and interpreting the news through photos, photo documentaries, and photo analysis. Open to majors only. P, 301, 302.

505.* The Study of News (3) I II [Rpt.] Critical study and problem analysis of the media. Field work may include publication of conclusions.

506.* Magazine Color Photography (3) S Techniques for taking and editing color photographs to illustrate magazine articles. Preparation of resumes and photo portfolios. Field trips.

511.* News Features (3) I II Writing the basic news feature article; specialized reporting and rewriting techniques. P, 206.

512.* Reporting for Magazines (3) II Study of writing techniques for magazines; analysis of in-depth features. Students will write articles for publication. P, 206.

513.* Reporting Public Affairs (3) I II Study and practice of newspapering on executive, legislative, and judicial levels in city, county, state and federal governments, with emphasis on news sources and interpretive writing. P, 206, 502.

514.* The News Agency: Arizona News Service (1) [Rpt.] I II Role and operations of the news agency, wire service or syndicate. Class members will form staff of Arizona News Service to supply client newspapers from bureaus in Tucson and Phoenix. Field trips. P or CR, 411 or 413.

517.* Sports News Writing (3) I Students will cover sports events and write sports features. Interview and rewriting techniques. P, 206.

518.* Travel Reporting (3) I II S Writing the basic feature article; specialized reporting and rewriting techniques. P, 206 or consult department before enrolling.

519.* Public Information Writing (3) I II S The history, principles and techniques of public information, the relationship between news media and government, and the responsibilities of government and other public information specialists. P, 206.


539.* Ethics and the News Media (3) I Analysis of ethical theory and how it relates to journalists' roles and responsibilities in a democratic society. Case studies involve questions of bias, accuracy, privacy and national security. (Identical with LAS 539)

550.* Community Journalism: The Tombstone Epitaph (3) [Rpt.] I II Class members work as editorial staff to produce the local newspaper for Tombstone, Arizona. Intensive study of problems and responsibilities of community newspapers. P, 206, 208, 301, discussion of preparation with instructor.

551.* Community Journalism: El Independiente (3) [Rpt.] I II Class members work as editorial staff to produce a publication for the community of South Tucson. Intensive study of problems and responsibilities of journalism. P, 206, 208, 301, discussion of preparation with instructor.

570.* The Press and Society (3) I II Critical study of press performance in current affairs; changing requirements for socially responsible and professional journalism in a democracy.

571.* International Communications (3) I II Study of world news systems, including news-gathering agencies, role of the foreign correspondent, the foreign press, the factors influencing international news flow.

596. Seminar
a. History of the Press (3) I II
b. Latin-American Press (3) I II (Identical with LAS 596h)
c. News Analysis (3) II
k. Risk and Society (3) I (Identical with GEOC 590, which is home)
m. Directions in News Technology (3) [Rpt./1] S

*May be convened with 400-level course.

Landcape Architecture
(See Renewable Natural Resources)

Latin
(See Classics)
Language, Reading and Culture (LRC)

Education Building, Room 512
(602) 621-1311

Professors Judy Nichols Mitchell, Head, Patricia L. Anders, Gary D. Fenstermacher, Kenneth G. Goodman, Yetta M. Goodman, Amelia Melnik (Emerita), Manuel T. Pacheco, Gabrielle Salomon, William J. Valmont
Associate Professors Adela A. Allen, John M. Bradley, Margaret B. Fleming (Emerita), Luis C. Moll, Richard Ruiz
Assistant Professors Dana L. Fox, Teresa McCarty, Kathleen G. Short, Octavia Trujillo
Clinical Assistant Professor Arminda Fuentesvilla

The department offers programs leading to the Master of Education degree with majors in bilingual/bicultural education and to the Master of Arts degree with majors in bilingual/multicultural education and in language, reading and culture. The department also offers programs leading to the Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in language, reading and culture.

An undergraduate grade-point average of at least 3.00 is required for admission to full standing in a graduate degree program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the department.

504. Language and Culture in Education (3) I II Introduction to aspects of language and culture that affect education, particularly in reading, writing and the language arts; discussion of social and political concerns.

505. Essentials of Reading and Writing (3) I II Survey of reading and writing relationships: development, instruction, and evaluation.

507. Teaching of Reading: Decoding and Comprehension (3) I II Linguistic, psychological and cultural bases of decoding and comprehension; theories that influence practice; materials and practice that facilitate learning to read.

510.* Foundations of Bilingual Education (3) I II Socio-cultural factors, language practices and education; analysis of theories and practices affecting bilingual learners; historical, social, and cultural influences; relationship of theory to the characteristics and needs of the bilingual learner.

512.* Educating the Culturally Diverse (3) I II Issues faced in education associated with ethnic and linguistic pluralism in the United States; analysis of the interaction of school, community, cultural and family factors in the education of diverse populations.

514.* Bilingual Reading and Writing (3) I Analysis of reading and writing situations encountered by bilingual students; phonological, semantic, syntactic aspects of instruction; methods and materials.

518.* Methods and Materials in Bilingual Education (3) I II Analysis and evaluation of methods and materials used in bilingual education programs; effective strategies in first and second languages; current and separate language approaches and cooperative models.

527. Developing Language Arts Curriculum (3) I II Curriculum theory and models; staff development for implementing change; scope and sequence; planning effective learning experiences. P, 504 and 505.

528.* Bilingual Curriculum Development (3) I II Theory and application of curriculum development to bilingual instructional programs; designs, organizational patterns, materials and media, change strategies, and evaluation.

530.* Computer Application for Teachers (3) I II Microcomputer operation; computer-assisted instruction; software evaluation; use of author systems and word processors in the classroom; computer-managed instruction; organization for computer use; communications networking; computer networking.

532. Pre-Reading and Beginning Reading Development (3) I II An examination of various aspects involved in pre-reading and beginning reading development, including psychological, sociological, physiological, linguistic and educational considerations.

535.* Content Area Literacy in a Multicultural School (3) I II Prepares teachers to integrate knowledge of cultural diversity and literacy processes with their content and specialization.

536.* Classroom Communications and Interaction (3) I II The teacher's role in promoting effective communication and interaction in the classrooms; analysis of both verbal and nonverbal uses of language.

537. Classroom Diagnosis and Instruction (3) I II Procedures for diagnosing and developing reading and writing skills for pupils of below-average achievement level. P, 505, 507 or CR.

551. Reading, Writing and Texts: A Psychosociolinguistic Perspective (3) I II Readers and writers as users of language; reading and writing as language processes; what makes a text a text.

553. Language Acquisition and Development (3) I Study of the development of language in young children; focus on oral language and its relationship to emergent literacy; instructional strategies that build on language development.

554. Applied Linguistics in Education (3) I The application to curriculum, teaching and learning of concepts from linguistics, psycholinguistics and sociolinguistics. P, 551 or CR.

557. Application of Miscue Analysis (3) I II Study of miscue analysis to explore the reading process, reading research, and readability, as well as to evaluate readers' applications to reading strategies and curriculum; focus on comprehension. P, 551 or CR.

560.* Children's Literature in the Classroom (3) I II Analysis and discussion of classic and contemporary children's literature of all genres, and its relationship to language, reading and culture.

561. Multiethnic Literature and Literacy (3) I II Analyzes the use of multiethnic literature that fosters self-concept, acceptance, and a sense of identity to develop literacy. Includes readings from the major categories of multiethnic literature about Black, Native, Hispanic, and Asian Americans.

563. Literature Discussions (3) I II Related to dialogue about children's literature within a community of readers. Research, theory and practice related to literature discussion groups, text, sets, reader response and collaborative learning.

599. Colloquium

a. Issues in Language, Reading and Culture (3-9) I II P, 504, 505. [Rpt. /12 units]

b. Language, Learning, and Reading Disabilities (3) I II (Identical with SER 599b, which is home)

c. Issues in Educating Bilingual/Multicultural Children (1-3) I II S [Rpt. /9 units]

d. Applications of Language and Literacy (3) I II S [Rpt. /9 units]

597. Workshop

a. Southern Arizona Writing Project (3-9) [Rpt. /12 units] I II S (Identical with ENGL 597a, which is home)

b. Miscue Analysis in Teacher Education (2-3) I II

c. Teaching of English (3) I II S [Rpt. /9 units] (Identical with ENGL 597a, which is home)

*May be convened with 400-level course.

612. Grammatical Analysis (3) I (Identical with ENGL 612)

613. Second Language Acquisition in Formal Contexts (3) I II (Identical with ENGL 613)

621. Curriculum Development and Supervision in Language Arts (3) I II Organizational patterns of language arts curricula; approaches to improvement of language arts instruction; personnel relations. Designed for the language arts supervisor and school administrator. P, 527

634. Reading Comprehension: Theories, Research and Methods (3) I II Factors affecting
cognitive development; methods of influencing growth in reading comprehension; examination and analysis of instructional materials; research related to comprehension and cognitive development. P, 507.

635. Reading and Writing in Content Areas (3) II Methodology appropriate for reading and writing to learn content; compatible organizational models; program implementation. P, 504, 505, 507 or 551 or CR.

636. Reading Diagnostic Laboratory (3–6) [Rpt./6 units] II Supervised practice in reading assessment; identification of factors influencing reading achievement, evaluation, construction, and administration of assessment procedures; development of interview techniques. P, 507, 537.

639. Reading Instructional Laboratory (3–6) [Rpt./6 units] II Supervised practice in teaching reading and writing; preparing, analyzing and critiquing special instructional programs for students. Open to majors only. P, 507, 537.

653. Written Language Development (3) I II Study of latest research in the writing and reading development of preschool and school-aged children; relationships between reading and writing development explored through student research; applications to instruction. P, 505, 553.

694. Practicum
a. Bilingual Education (3) [Rpt./2] P, 15 graduate units including 510 and 524.

696. Seminar
a. Language, Reading and Culture (1–3) [Rpt./6] P, 15 graduate units including 504, 508.

b. Research in Bilingual Education (1–6) I II

c. Research in Language and Literacy (1–6) [Rpt./9 units] I II

795. Colloquium
a. Theory and Research in Language, Reading and Culture (1–3) [Rpt./15 units] I II

796. Seminar
a. Research and Evaluation in Language, Reading and Culture (1–3) [Rpt./15 units] I II

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**Latin American Studies (LAS)**

1522 E. Drachman St.

(602) 622-4002

Latin American Area Center
Director Donna J. Guy
Assistant Director Raul P. Saba

Graduate Interdisciplinary Program in Latin American Studies

Committee:

Professors Nathan Buras (Hydrology and Water Resources), Donald W. Carson (Journalism), Ken Clark (Architecture), T. Patrick Culbert (Anthropology), Celestino Fernández (Sociology), Roger Fox (Agricultural and Resource Economics), Donna J. Guy (History), Lain A. Gyurko (Spanish and Portuguese), Boris S. Kozolchik (Law), Oscar Martinez (History), Michael C. Meyer (History), Andrew Nichols (Family and Community Medicine), Leland Pederson (Geography and Regional Development), Jose Promis (Spanish and Portuguese), Eliana Rivero (Spanish and Portuguese), Jacqueline Sharkey (Journalism), Arthur Silvers (Public Administration and Policy), Charles M. Tatum (Spanish and Portuguese), Edward J. Williams (Political Science)

Associate Professors Kevin Gosner (History), Keith McElroy (Art), Alfonso Moises (Media Arts), Richard Obergon (Music), Richard Ruiz (Language, Reading and Culture), Kathleen Schwartzman (Sociology), Barbara Timmermann (Pharmaceutical Sciences)

Assistant Professors Maria Jose Barbosa (Spanish and Portuguese), Thomas Barwick (Archaeology), Bert J. Barlow (Political Science), Virginia Escalante (Anthropology), Ana Virginia Perches (Spanish and Portuguese), Raul P. Saba (Latin American Studies), Stacie Widdifield (Art), Amy Williamsen (Spanish and Portuguese)

The Latin American Area Center offers an interdisciplinary M.A. program combining Spanish and Portuguese language skills with courses focusing on two fields of study, a core Latin American Studies research seminar and optional electives. The student chooses one of the fields as the primary area of concentration and the other field as a secondary area of concentration. The course of concentration include the disciplines of anthropology, geography and regional development; history, language, reading and culture; political science; and Portuguese or Spanish. An area of concentration also may include a cohesive program of related courses with a geographic focus. Presently, these geographic areas include Mexico studies and Brazil studies. Related fields for the secondary area of concentration include the disciplines of: agricultural and resource economics; art history; anthropology; economics; geography and regional development; history, journalism, language, reading and culture; law; political science; sociology; and Portuguese or Spanish. The student might also focus this secondary field around more thematic areas such as inter-American political economy and trade, race and class, women's studies, indigenous cultures, and border studies (if the Mexico studies option has not been selected for the concentration). A total of 36 graduate units are required for the M.A. degree. A minimum of 15 units, including a research seminar, are chosen in the area of concentration. The secondary area consists of a minimum of nine units. The research seminar (596a) is three units. The nine remaining units consist of thesis credit (6) and/or elective course work. Although not required, a thesis is strongly encouraged. It is also advisable that one or more seminars be included among the courses taken in the secondary and elective areas.

Because of the interdisciplinary nature and regional emphasis of the Latin American studies program, both Spanish and Portuguese skills are required; one at the level of competence demonstrated by completing Portuguese 206 or Spanish 251b or by an equivalency exam; the other at the level of proficiency demonstrated by completion of Portuguese 405 or Spanish 330 with a grade of B or by an equivalency exam. Students accepted into the program who do not meet one or both of the language requirements may satisfy this deficiency during the course of their graduate studies. Moreover, if a student has a regional or country focus in the area of primary concentration, he or she must take at least two courses emphasizing other areas or countries in Latin America.

Applicants are asked to submit two letters of recommendation, a one-page statement of purpose or goals, and scores on the Graduate Record Examination. An admissions subcommittee takes into consideration all factors when evaluating applicants to the graduate programs.

Doctoral students in other departments may elect a minor in Latin American studies. Requirements include a minimum of 15 units in courses related to the student's major and demonstrated competence, as defined above, in either Portuguese or Spanish.

504.* Architecture and Planning in Mexico (3) I (Identical with ARCH 504)

506.* Economic Anthropology (3) II (Identical with ANTH 509)

511.* Middle America (3) II (Identical with GEOG 511)

512.* South America (3) I (Identical with GEOG 512)

512.* Cultures of Ancient Mexico (3) I (Identical with ANTH 517)

522a-522b.* Pre-Columbian Art (3-3) [Identical with ARH 522a-522b]

523.* Anthropology of Mexico (3) II (Identical with ANTH 523)

530. Development of Spanish Literature from the Pre-Columbian Period to Independence (3) (Identical with SPAN 530)
**Law (LAW)**

**Law Building, Room 110**

(602) 621-1373


Associate Professors Lynn A. Baker, Jane B. Korn

Assistant Professor Ronald J. Rinaldi

The College of Law offers course work leading to the Juris Doctor degree. The course program has been thoroughly revised and expanded to include a modernized set of required courses and a wide variety of problem-method courses, seminars and clinical programs. For course descriptions and degree requirements, please see the College of Law Catalog.

**600. Contracts (5)**

601a-601b. Introduction to Legal Process and Civil Procedure (3-2)

602. Criminal Procedure (4)

603. Research and Writing (2)

604a-604b. Torts (2-3)

605. Property (5)

606. Constitutional Law I (3) I

607. Appellate Practice and Moot Court (1)

608. Evidence (4)

609. The Legal Profession (2)

610. Health Law (3) III

611. Employment Law (3) I

612. Family Law (3) II

613. Law and Medicine (3) II

615. Constitutional Law II (4) II

616. Corporations (3) II

617. Corporate Finance (2) II P, 616.

618. Antitrust Law (3) II

619. Estates and Trusts (4) I

620. Immigration Law (3) I

621. Administrative Law (3) II

622. Law Review (1-3) III

623. Conflict of Laws (3) I

624. Labor Law (3) I

625. American Legal History (2) I

626. Jurisprudence (3) I

627. Copyright (2) II

628. Comparative Law (3) I

629. Agency and Partnership (2) I II

630. Law and Humanities (3) II

631. Indian Law (3) I (Identical with ANNS 631)


633a-633b. Commercial Transactions (3-3)

633a is not prerequisite to 633b.

634. Basic Insurance (3)

635. Arizona Civil Procedure (3) II

644a-644b. Remedies (1-3)

645a-645b. Trial Practice (2-3) P, 608, 609.

646. Federal Income Taxation (5) I

647. Corporate Taxation (3) II P, 646.

648. Estate and Gift Taxation and Basic Estate Planning (3) I

649. Torts II (3) II

650. Criminal Law (3) II

652. Income Taxation of Estates and Trusts (2) II P, 646.

653. Advanced Appellate Practice and Moot Court (2) II

654. Sentencing Law (2) II


658. Securities Regulation (3) II

659. International Humanitarian Law (3)

660. Land-Use Planning (3) II

661a-661b. Moot Court Board (2-2) 661a: Moot Court National Team. 661b: Moot Court Board.

662a-662b. Debtors-Creditor Law (1-2) I II

662a: Debtors-creditor law. 662b: Bankruptcy. 662a is not prerequisite to 662b.

663. Individual Income Tax (3) I

664. Law and Social Science (2) II

665a-665b. Interviewing, Counseling and Negotiating (1-1) 665a is not prerequisite to 665b.

666. Lawyering Skills Outside the Courtroom (2) I II P or CR, 698c or substantial clerking experience.
and the Doctor of Philosophy degrees with a major in library science. The master’s program is fully accredited by the American Library Association and requires a minimum of thirty-six units of graduate credit. Students may elect the thesis option replacing six units of course work.

Doctoral students must complete at least 48 hours of course work in the major; a minor subject supporting the major, and the dissertation. More detailed descriptions of the program are available from the school.

501. Introduction to the Organization of Information (3) Introduction to the theories and practices used in the organization of information. Overview of national and international standards and practices for access to information in collections.


503. Library Collection Development (3) Principles of collection development; evaluation and review of materials; selection tools; problems in selection, including censorship.

504. Foundations of Library and Information Services (3) Elements of librarianship, historical backgrounds, types of libraries, the role of the library in American life, current issues.

505. Basic Reference (3) Survey of general reference sources; discussion of reference technique.

506. Research Methods (3) Need and opportunities for research in librarianship; types of research; research methodology; study of research design; elementary statistics.

507. Library Management (3) Introduction to management concepts, the organizational structure of libraries, systems analysis, financial administration and the utilization of library personnel.

509. Information Sources for Agricultural Scientists (1) (Identical with PL S 509)

510. Introduction to Information Science (3) Methods, theories, and technology of information science; elements of computer programming and systems design; implementation and management of computer systems in libraries and information centers.

511. Information Storage and Retrieval (3) Student involvement in on-line, interactive systems.

512. Automation in Libraries (3) Introduction to automated procedures currently in use in libraries, including systems analysis of actual technical services and planning for their automation.

513. Library Systems Analysis (3) Introduction to quantitative methods for the design, analysis and control of library systems.

519. Cartographic Information Management (3) Cartographic format as an information transfer medium. History of cartography and problems in interpretation of cartographic products. Role and place of maps in the information environment.

521. Advanced Cataloging (3) Comparative study of Dewey Decimal Classification and Library of Congress Classification; advanced problems in descriptive cataloging; subject headings, and library filing.

526. Introduction to Bibliography (3) Introduction and critical examination of various styles of bibliographic description; practical application in construction of a systematic bibliography.

530. Public Librarianship (3) Administration of tax-supported libraries serving the general public, including problems of governmental relationships, community responsibilities, financial support, buildings, personnel, collections.

540. Academic Librarianship (3) Present trends in academic libraries, including financial administration, collection evaluation, personnel requirements and building needs.

550. Special Librarianship (3) Mission, organization and administration of the special library.

551. Corporate Librarianship (3) History, types of libraries, staffing, development and future of company libraries in the United States.

559. History of Books and Printing (3) Survey of the history of books and printing from early times to the present, including development of the alphabet, manuscript books, the invention and dissemination of printing and modern printing techniques. (Identical with HIST 559)

561. History of Children’s Literature (3) Survey of literature for children in England and America from earliest times to the close of the 19th century, together with study of cultural and social values reflected in the literature. (Identical with ENGL 561)

570. Literature of Science and Technology (3) Creation, organization, and dissemination of scientific and technical literature; reference function and problems of bibliographic control. A science background is not required.

571. Information Sources and Services in the Social Sciences (3) Information resources and services in history, geography, political science, sociology, anthropology, psychology, education, economics and business.

572. Information Sources and Services in the Humanities (3) Information resources and services in art and architecture, music, language and literature, theatre and dance, philosophy and religion.

573. Government Publications (3) Examination of the varieties of government publications available from municipal, county, state, national and international agencies, with emphasis on selection and use of publications of the U. S. government.

575. Human Factors in Information Systems (3) Study of the human-information system interface: libraries, computers, human-information processing, physical-psychological
factors in design and operation of information systems.


581.* School Library Administration and Organization (3) Services, finance, personnel, evaluation, quarters, organization and technical services in the school library.

582. Management of Nonprint Resources (3) Examines management of nonprint resources and their role in providing informational, recreational and educational services.

583.* Literature for Adolescents (3) Literature and their role in providing informational, recreational and educational services.

584.* Literature for Children's Librarians (3) Literature and their role in providing informational, recreational and educational services.

585. Scholarly Communication (3) Structure and workings of scholarly communication and products in the U.S. Examines the content and technology of scholarly communication in various disciplines. (Identical with COMM 589)

*May be convened with 400-level course.

586. Introduction to Graduate Study in Music (3) (Identical with MUS 600)

587. Planning Library Services (3) The total planning cycle as a management approach to various library/information center services. Open to majors only.

588. Evaluation of Libraries (3) Examines the process of evaluation and analytical decision making in assessing library services and procedures.


590. Scientometrics and Bibliometrics (3) Examines quantitative techniques for measuring scientific and technical literature. Covers history and theory as well as current techniques. Emphasis on current research and theory.

591. National and International Information Policy (3) Investigates the formulation and implementation of those laws and policies that govern the flow of scientific and technical information in the United States and between the United States and selected countries.

592. Colloquium e. Theory of Classification (1-3)
   h. Children's and Youth Services and Literature (2-3) [Rpt.]

593. Seminar a. Current Research Trends (1-4) [Rpt.]
   b. Government Information Issues (3)
   c. Issues in Library and Information Science (1-4) [Rpt.]
   d. Current Resources in School Libraries (3)

Linguistics (LING)

Douglass Building, Room 200E  
(602) 621-6897

Professors D. Terence Langendoen, Head, Richard Demers, Merrill Garrett (Psychology, Speech and Hearing Sciences), Robert M. Harnish (Philosophy), Jane Hill (Anthropology), Adrienne Lehrer, Susan Steele

Associate Professors Diana Archangeli, Michael Hammond, Richard T. Oehrle, Ofelia Zepeda

Assistant Professors Andrew Basset, Paul Bloom (Psychology), Molly Diesing, Simin Karimi (Near Eastern Studies), Janet Nicol

The Department of Linguistics offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in linguistics. For the doctorate, specializations are available in the following areas: linguistics and philosophy, theoretical syntax, theoretical phonology, morphology, Chinese linguistics, Japanese linguistics, Native American linguistics, education/pedagogical linguistics, socio-cultural linguistics, language acquisition and development, and language processing.

Applicants for admission must forward to the department scores on the aptitude test of the Graduate Record Examination, three letters of recommendation from previous instructors or academic advisors, a sample of work, and a departmental application form.

Degrees

All students, regardless of their intended specialization or degree objective, are expected to complete the following courses: 501, 503, 510, 511, 533, 564, 595a (two semesters) and either 504 or 505. These courses cover the foundations and major current developments in the phonology, morphology, syntax and semantics of natural languages.

Master of Arts: A total of 30 units of course work is required, including all of the courses listed above. A master's examination consisting of the submission of an expanded term paper is required. The paper must be approved by a committee of the student's advisor and two other faculty members. No thesis is required.

Doctor of Philosophy: In addition to the courses listed above, students must complete 697a, two seminars and a dissertation. Additional courses and seminars are required depending on the student's area of specialization and minor field. A minor taken within the department consists of 12 units. The qualifying examination consists of the submission of two research papers to the faculty, normally at the end of the third semester. The written preliminary examination consists of the submission to the faculty of a research paper of the scope of a journal article, normally at the end of the fifth semester. A dissertation proposal must be approved by the student's dissertation director within six months of passing the oral preliminary examination. Further information about the graduate program is provided in the Handbook of Policy for the Graduate Program in Linguistics, which is available upon request from the department.

500. Linguistics for Nonmajors (3) I 1994-95 Conceptual foundations, methodology, and current theoretical frameworks. Students will carry out actual linguistic analysis. For students in fields other than linguistics.

501. Formal Foundation of Linguistics (3) I A survey of the aims of linguistic research and introduction to the basic mathematics of formal linguistics: logic, sets, algebras, graphs, feature structures, formal language theory.

502.* Gender and Language in Japan (3) II 1994-95 (Identical with JPN 502)

503. Foundations of Syntactic Theory I (3) I Introduction to fundamental issues in the theory of syntax. Familiarizes the student with the essentials of (1) government binding theory and its predecessors, and (2) standard categorial grammar and its relatives. P, 101, 300.

504. Government Binding Theory (3) II Continuation of 503, focusing on government, control, binding, thematic relations, and the theory of logical form.


510. Foundations of Phonological Theory I (3) I Investigation of the principles that underlie current phonological theory, concentrating on the representation of sounds and the regular patterns of sound in natural language. Topics include distinctive feature theory, syllable theory, the core skeleton, rule formulation and rule interactions. P, 101, 315.

511.* Introduction to Japanese Linguistics (3) (Identical with JPN 511)

512.* Advanced Japanese Linguistics (3) (Identical with JPN 512)

514. Foundations of Phonological Theory II (3) II Investigation of the evidence and arguments for non-linear representations (autosegmental and metrical) and of the organization of the phonological component of grammar, including evidence for its interaction with morphological structures and rules.

515. Phonological Phonetics (3) I 1994-95 Study of the acoustic and articulatory properties of sounds and patterns of sounds that
occur in human language. Focus on the significance of the properties of sounds for phonological theory, in particular, distinctive feature theory. Role of psycho-acoustic studies as a source of evidence for phonological theory.

519.* Linguistic Structure of Modern Chinese (3) (Identical with CHN 519)

520.* Linguistic Structure of Modern Chinese (3) (Identical with CHN 520)

522.* Linguistic Semantics and Lexicology (3) II 1994-95 Study of word and sentence meaning, relationship between the lexicon and the grammar, idioms, metaphor, etymology, and change of meaning. P, one course in linguistics. (Identical with PHIL 522)

525.* Language Variation (3) II 1993-94 Study of geographical and social dialects, stylistic differences, and idiolectal variation and the implications of variation for writing grammars and for understanding language change. P, one course in linguistics, preferably LING 101 or ANTH 276. (Identical with ANTH 525)

526.* Introduction to Arabic Linguistics (3) II (Identical with ARB 526)

535. Morphology (3) I Morphology is the internal structure of words and the relationship between words and the syntactic, phonological, and semantic properties of the units that include them. Course work includes the development of morphological theory.

536.* Japanese Sociolinguistics (3) [Rpt./1] I (Identical with JPN 536)

540. Linguistic Change and Diachronic Theory (3) I 1993-94 Current theories in historical linguistics, including the study of the mechanisms and consequences of language change and the methods of linguistic reconstruction. Particular languages and areas of linguistics vary with the instructor. (Identical with NES 540)

544. Syntactic Analysis (3) I 1994-95 An examination of the syntactic diversity presented by natural human languages and an exploration of the issues that such diversity presents for syntactic analysis. Topics include AUX, word order, constituency, and subjects.

545a-545b. * Structure of a Non-Western Language (3-3) [Rpt./3] I 1994-95 In-depth linguistic analysis of selected phonological, syntactic, and semantic problems in a non-Western language, concentrating on native languages of the Southwest area. P, 101. (Identical with ANNS 545a-545b)

551.* Language Acquisition (3) II (Identical with SP HN 551)

553. Lexical and Syntactic Development (3) I II (Identical with PSYC 553)

561.* Linguistics and the Study of Literature (3) II 1994-95 Identical with CCLS 561)

563.* Philosophy of Language (3) (Identical with PHIL 563)

564. Formal Semantics (3) (Identical with PHIL 564)

565.* Pragmatics (3) II (Identical with PHIL 565)

573.* Natural Language Processing (3) II Introduction to the processes underlying

Management and Policy (MAP)

McClelland Hall, Room 405
(602) 621-1035

Professors Michael R. Gottfredson, Head, Lee R. Beach, Terence Connolly, Edwin B. Flippo (Emeritus), Barbara A. Gutke, James P. Logan (Emeritus), Raymond A. Mulligan (Emeritus), Thomas R. Navin (Emeritus), Gregory B. Northcraft, Amon Rapoport, George W. Summers (Emeritus)

Associate Professors Lawton R. Burns, Marvin Fortman, H. Britton Milward, David A. Tansik, Robert E. Tindall

Assistant Professors Terri L. Griffith, Kenneth W. Kropot, Sherry K. Schneider, Christina Shalley

The department participates in programs leading to the Master of Business Administration, the Master of Public Administration, and the Doctor of Philosophy degree with a major in management. For information concerning these degrees, see Requirements for Master's Degrees/Master of Business Administration and Master of Public Administration elsewhere in this catalog.

For admission, the applicant is expected to have completed undergraduate work in statistics and mathematics through calculus (MATH 119 and 123). Applications must submit scores on the Graduate Record Examination or the Graduate Management Admissions Test.

The program for the Doctor of Philosophy degree is designed to prepare individuals for careers in academia with an emphasis on the ability to make original and significant contributions to the disciplines of management and policy, and judgment and decision making, through high quality research. To this end, the Ph.D. program provides strong theoretical and methodological training to doctoral students.

500. Management Case Analysis and Presentation (3) I II Written analysis of cases and other reports; development of skills in analysis, decision making, and written and oral presentation, with emphasis on the total situation of each case considered.

502. Organization Theory and Behavioral Relations (3) I II The interactions, effects, and interrelationships of managers, employees, and organizational structures and systems. Open only to students admitted to a B.P.A. graduate program.

503. Human Resource Management (3) I Principles, methods, research relevant to management of an organizations human resources, with emphasis on employment psychology, training, development, compensation. P, 305 or 502.

504. Organization Development and Change (3) I II Concepts and skills relevant to persons concerned with problem diagnosis and organizational development and change. P, 305 or 502.

505. Organizational Power (3) I II Development of organizational power and influence techniques for individuals and groups. Uses cases and practical experience to build on motivation, negotiation, and group dynamic skills. P, 502.

532. Conflict and Cooperation in the Dyad (3) I Critical exposition of the essential ideas of two-person game theory and the findings
of experimental research on strategic interactions in the dyad.

535. International Management (3) I II S Analysis of management opportunities and challenges; evaluation and formulation of strategies of firms expanding internationally. (Identical with PA 535)

537. Finance for New Ventures (3) I (Identical with FIN 537)

538. Marketing, Negotiation and Decision Tactics (3) II Development of bargaining and decision-making skills through simulated negotiations and role playing. Open only to students in the entrepreneurship program. P, ECON 500a-500b, FIN 511, MKTG 500. (Identical with MKTG 538)

539. Planning of New Ventures (3) II New venture development, financial projections, resource assessment, and long-range planning. Open only to students in the entrepreneurship program. P, ECON 500a-500b, FIN 511, MKTG 500. (Identical with FIN 539)

543. Interactive Behavior in Small Groups (3) II Critical examination of the essential ideas of experimental research on social dilemmas, including: social determinants of career topics having to do with gender and organizational systems. Focus on contemporary organizational issues and managerial responses to them. P, 305 or 502.

556. Gender Issues in Organizational Behavior (3) Reviews the research on several topics having to do with gender and organizational issues, including: social determinants of career choice; occupational sex segregation; perceptions of men and women as managers; gender issues in motivation, leadership, and job satisfaction; work and family issues; implications of technological change for women's employment; organizational change including affirmative action and comparable worth. (Identical with SOC 556)

559. Motivation and Leadership (3) II Development of bargaining and decision-making skills through simulated negotiations and role playing. Open only to students in the entrepreneurship program. P, ECON 500a-500b, FIN 511, MKTG 500. (Identical with FIN 539)

568. Environmental Scanning and Business Strategy (3) I (Identical with MKTG 568)


580a-580b. Theory of Management and Organization (3-3) 580a: Analysis of behavior in organizational systems; review of classical, behavioral, and contingency theories of management with a focus on internal systems phenomena. 580b: Organizations in their environments; analysis of organizations in the context of their environmental interfaces. P, 305 or 502. 580a is not prerequisite to 580b.


595. Colloquium

600. Behavioral Science Theory and Method in Management (3) [Rpt./I] I Conceptual and theoretical frameworks for the analysis of management problems from a behavioral science perspective. Emphasis on formulation of research questions and alternative research strategies for answering them.

635. Issues in Rural Health Care (3) II (Identical with NURS 635)

693. Internship

696. Seminar

Management Information Systems (MIS)

BPA Building, Room 406
(602) 621-2748


Associate Professor Nicholas Aquilano, Moshe Dror, Sudha Ram, Olivia R. Liu, Sheng, Douglas R. Vogel

Assistant Professors Ai-Mei Chang, Hsing-Chun Chen, Joey George, Janny Leung, Sarma Nidumolu, Titus Purd

The department offers a program leading to the Master of Science degree with a major in management information systems. The department also participates in programs leading to the Master of Business Administration, Master of Public Administration, and Doctor of Philosophy (major in management) degrees. Management Information Systems involves the use of computers in organizations and the integration of computer skills with the functional areas of management. Education in management information systems enables students to pursue careers involving the use, definition, analysis, design, implementation, and operation of computer information systems.

To be considered for admission, applicants must have earned a competitive, acceptable score on the Graduate Management Admissions Test and a competitive undergraduate cumulative grade-point average. Applicants must also have completed preparatory work in mathematics, statistics and business.

The program requires the completion of 30 graduate units, including a master's project (696h).

501. Management Information Systems (3) I Introduction to managerial issues raised by the use and implementation of information technologies in business. Emphasis is on organization and technical foundations of information systems, problem solving skills using PC-based software.

507a-507b. Information Systems Architecture and Data Communications (3-3) 507a: Fundamental concepts of operating systems. The principles and techniques required for engineering and understanding operating systems are covered. Examples from real systems are given to illustrate application of particular concepts. Hardware architecture that is relevant for understanding operating systems. 507b: Comprehensive view of data and computer communications. Explores key issues in the field, in the general categories of principles (including basic concepts and terminology used in the field), design approaches and applications in business; standards such as the IEEE, OSI, TCP/IP and others. P, 507a.

511. Social Issues of Computing (3) I II S Broad survey of the individual, organizational, cultural, social and ethical issues provoked by current and projected uses of computers.

521a-521b. Advanced Systems Modeling and Simulation (3-3) 521a: Simulation concepts, simulation software, modeling of systems, model validation, selecting input probability distributions, random variate generation, statistical analysis of output data and SIMAN simulation language. P, fundamental knowledge of probability and statistics. 521b: Modeling and analyzing complex business systems using advanced simulation and statistical techniques. A semester project is required. P, 521 or equivalent course. (Identical with C SC 521a-521b)

522. Mathematical Programming and Applications (3) I Formulation and solution of mathematical programming models for decision making. Topics include linear programming, network flow models and integer programming. These models are applied in systems design, manufacturing, logistics, finance, and other areas. P, MATH 119

531a-531b. Data Structures and Database Management (3-3) 531a: Abstract data types, data structures and their implementation in
Pascal programs. Data structures covered include stacks, queues, lists and trees. 531b: Introduction to concepts of database processing in comparison with file processing. Review of file organization and relevant data structures. Detailed study of database management systems and their application to logical and physical design. Detailed study of data flow diagrams and the entity-relationship model, Relational and CODASYL database models, as well as implementation aspects for a database system. Database applications using SQL/DS on the IBM 3090. P, 533a or equivalent data structure course and knowledge of the IBM 3090 (VM/CMPS environment).

541a-541b. Computer-Aided Information Systems Analysis and Design (3-3) Introduction to the management and techniques associated with software development, both domestically and internationally with focus on the analysis and design stages. Emphasizes international issues. Involves "hands-on" experience with Computer-Aided Software Engineering (CASE) tool. (Identical with C SC 541a-541b)

550. International Dimensions of Information Technology (3) I National and regional information technology development strategies and policies; IT and national sovereignty, development and control of global "information highways." Impact of public and business policies on information systems design and use; international institutions and IT; convergence or divergence of information systems across countries, regions and international economic sectors.

551. Advanced Business Programming (3) I Business systems programming environment; basic and advanced COBOL; file organization and access methods; external sort and multikey files; 4GLs in data processing. P, 501.

553. Software Systems (3) I II Software development and software engineering; brings together the elements of programming language, operating system, and development techniques; teaches and uses the C programming language and the Unix operating system.

554. Computer Graphics (3) II Interactive computer graphics; user interface design; pictorial data structures and management. P, 531a.

567. Design and Control of Production Systems (3) I II Introduction to the basic concepts in operations management. Topics covered include project planning, aggregate planning, forecasting, classical inventory models, linear programming and simulation. Open only to graduate students in BPA.

570. Management and Evaluation of Information Systems (3) I II The methodologies of economics and management information systems applied to the problem of designing and evaluating information systems for a profit-maximizing firm. An MBA integrative course. Open only to students admitted to BPA graduate programs. P, 501, ACCT 550, ECON 500a. (Identical with ACCT 570 and ECON 570)

572. Operations Management (3) I Manufacturing operations from a tactical standpoint. Major topics include materials requirements planning, capability management, scheduling and JIT planning and control. P, 567 or consent of instructor.

573a-573b. Production and Operations Management (3-3) Productive systems, including service type industries; activities entailed in selecting, designing, operating, controlling, and improving productive systems. 573a: Forecasting, aggregate planning, MRP, inventory models under uncertainty, scheduling, P, 573. 573b: Capacity expansion and facility location, facility layout, assembly line balancing, new technologies (GT, FMS, CAD/CAM) project management, case studies in manufacturing and services.

574. Current Topics in Operations Management (3) II Coverage of new techniques and technologies in operations management. Examples of topics that may be covered are JIT, OPT, robotics. P, 473b or CR.

575. Productivity Improvement (3) I Topics in productivity measurement, evaluation and control: work measurement, job design, statistical quality control, productivity improvement through effective management. P, 373.

576. Management of Service Operations (3) I Application of operations management concepts to service organizations; exploration of critical issues such as facility location, layout, scheduling, and capacity management; case analyses and/or term project. P, 373.

577. Materials and Logistics Management (3) I Organization and control of material flow processes; logistical strategies and relationships of procurement, handling, warehousing, transportation, and inventory control. P, 373, 473a.

578. Project Management (3) I II Definition of programs and projects, organizational forms, developing the work breakdown structure, scheduling techniques (PERT and CPM), control mechanisms such as milestones, cost reports and progress reports. Lectures and case analyses. P, 305, 373.

579. Computer Models for Operations Management (3) I II Use of available software packages to analyze complex operations management problems. P, 473b or CR.

580. Introduction to Expert Systems (3) I II An in-depth technical background of the concepts and skills essential to analysis, design and development of business expert systems. Open only to BPA graduate students.

583. Stochastic Models in Management Science (3) II Markov chains, models or arrival processes, continuous-time Markov chains, queuing theory, models of computer and manufacturing systems.

584. Combinatorial Optimization and Integer Programming (3) II Introduction to the formulation, solution, and implementation of integer programming models, for decision making where the choices are discrete. Topics include network flow models, computational complexity, branch-and-bound and cutting-plane methods. P, 422 or 522.

585. Manufacturing Strategy (3) II 1993-94 Strategic issues in operations management. Topics include process choice and positioning, product profiling, focused manufacturing, infrastructure development, integration of marketing, accounting and manufacturing strategy and JIT manufacturing, P, 572 or consent of instructor.


588. Systems Design for Management (3) I II Focuses on automated tools to support managers in organizations including office automation, decision support systems, GDSS; applications and methodologies for designing, implementing, and evaluating such systems and their organizational impact.


590.* May be convened with 400-level course.

611a-611b. Topics in Research Methodologies in MIS (3-3) 611a: Introduces beginning doctoral degree students and advanced master's degree students to important research and survey articles in the field of management information systems. 611b: Provides a knowledge of research methodologies used in the MIS discipline, including experimental design, surveys, case studies, field work, and software engineering.

671. International Issues (3) I Analyses of industry successes and failures in global markets, focusing on the national characteristics, company strategies and national policies behind them. Case studies of more than 20 countries around the world (most of which will be student generated). Regional developments and problems. Sectorial emphases on international technological developments and issues related to the globalization of the information technologies. P, graduate standing and at least one 500-level MIS or equivalent course.

680. Artificial Intelligence and Expert Systems (3) I In-depth discussions of advanced AI topics such as natural language processing, cognitive modeling techniques, machine learning techniques, and neural network computing. Hands-on projects are required. P, 531a. Open to all graduate students.

696. Seminar
a. Readings in MIS (3)
b. Group Support Systems (3)
c. Emerging Information Technologies (3)
d. Research Techniques in MIS (3)
e. Recent Advances in MIS (3)
g. Advanced Topics in Data Management (3)
h. Master's Report Projects (3) S Open to majors only.
i. Management of Executive Information Systems (3)

796. Seminar
a. Research Issues (3) [Rpt./6 units] Open to majors only.
Marketing (MKTG)
McClelland Hall, Room 320
(602) 621-7479

Professors Ambar G. Rao, Head, Dipankar Chakravarti, Joseph W. Newman (Emeritus), John H. Wieland (Emeritus)
Associate Professors Merrie L. Brucks, Bernard J. Jaworski, Deborah J. MacInnis, Christopher P. Puto, Richard A. Scott, Melanie R. Wallendorf
Assistant Professors Helen H. Anderson, Jonathan Frenzen, Susan E. Hecker, Pallassana Kannan, Praveen Kopalle, Jayashree Mahajan

The department offers a program leading to the Master of Science degree with a major in marketing. The department also participates in programs leading to the Master of Business Administration degree with a major in business administration and the Doctor of Philosophy degree with a major in management. Information concerning these degrees see Requirements for Master's Degrees/ Master of Business Administration and the headnotes under Business Administration elsewhere in this catalog.

The Master of Science degree program prepares students for marketing careers which require strong empirical research skills. The program also is an efficient step toward the Ph.D. program with a major in management for students holding undergraduate degrees.

For admission, the applicant is expected to have completed undergraduate work in managerial accounting, economics, finance, marketing, organizational behavior, production, business policy, statistics, and mathematics through calculus. Some background requirements may be satisfied after admission. A superior score on the Graduate Management Admissions Test and evidence of strong academic performance at the undergraduate level are required for admission consideration.

Credit earned in fulfilling the background requirements named above will not count toward the 39 units of course work required for the M.S. degree. The 39 units include nine units for either a Master of Science degree with a major in management for students holding undergraduate degrees.

500. Marketing Management (3) II Scope, environment and nature of marketing management; customer and market analysis for product, service, price, promotion and distribution decisions. Open only to students admitted to B.P.A. graduate programs.

530. Management of Marketing Communications (3) I Application of communications theory and research findings in advertising, sales promotion, public relations, personal selling, personal selling, conduct and administration of programs of information and persuasion. P, 500.

536. Innovation and Economic Growth (3) I Role of entrepreneurship and innovation in economic growth. Development of the new venture idea and assessment of market potential. Open only to students in the entrepreneurship program. P, ECON 500a, FIN 511, MKTG 500. (Identical with ECON 530)

538. Marketing, Negotiation and Decision Tactics (3) II (Identical with MAP 530)

550. Consumer and Organizational Buyer Behavior (3) I Nature of the purchase decision process for goods and services. Theories, concepts and research methods and findings are examined for use in management and public policy decision making. P, 500.


552. Statistical Decision Making (3) I II Probability and statistical analysis; random variables, sampling distributions, hypothesis testing, Bayesian analysis, time series, statistical investigation. Open only to students admitted to a BPA graduate program. P, MIS 400, or MATH 119 and 123.

554. Management of Sales Operations (3) I II The sales function and its relationship to the total marketing program; sales strategies and objectives; development and administration of sales organizations; control and evaluation of sales operations. P, 361, 376, MATH 123.

557. Industrial Marketing (3) II Problems and methods of marketing decision making in industrial, government and high-tech markets. P, 500.

559. Product Strategy (3) II Formulating and implementing strategy for growth; analyzing and influencing market structure; developing, pricing, testing new entries; managing the portfolio. P, 500.

560. International Marketing (3) II Marketing planning and strategies for foreign environments; cultural, political, economic factors affecting the international marketer, multinational corporation and multinational market groups. P, 500.

565. Management for Global Competitive Success (3) II Developing comprehensive strategies and programs for delivering quality goods and services to consumers as a basis for global competitive success. P, 500 or consult department before enrolling.

568. Environmental Scanning and Business Strategy (3) III An MBA integrative course. How information from the economy can be used to develop a firm's competitive strategy. Multi-disciplinary, using concepts from economics, marketing and management. Open only to MBA graduate students. Includes case method approach to problems facing top management in making and effecting a strategic plan. P, 500, ECON 500, FIN 511. (Identical with ECON 568 and MAP 568)

572. Marketing Research for Managers (3) I Specification of management information needs, evaluation of research proposals and findings, methods of gathering and analyzing data, administrative aspects of research and decisions. P, 500.

582. Multivariate Analysis in Management (3-3) 582a: Multiple, polynomial, stepwise regression including indicator variables, inference, remedial measures. 582b: Analysis of variance and covariance, principal components, discriminant analysis, canonical correlation. P, 552 or STAT 273. 582a is not prerequisite to 582b.

587. Workshop
a. Research Design (3) [Rpt./S] I II P, 796a.

Materials Science and Engineering (MSE)

Mines Building, Room 131
(602) 621-6070


Associate Professors Dunbar P. Birnie, III, Pierre A. Deymier
Assistant Professors Brian D. Fabes, Supapan Seraphin, Brian J.J. Zelinski

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in materials science and engineering.

The graduate programs in the department are designed to provide advanced study in the fields of materials properties, materials structures, and materials processing. Emphasis is placed on metals, alloys, electronic materials, ceramics, and composites. Courses and research are provided in extraction, thermodynamics, kinetics, transport, microstructural characterization, physical properties, processing and application.

Degrees

Master of Science: The course requirements for the Master of Science degree are 18 units of regularly scheduled 500-level courses specified by the department; 4 units of colloquium, independent study, or regularly scheduled graduate-level courses; and 8 units of thesis (30 units total). Precise details of the course requirements are available from the department office.

Students may transfer up to six units of course work completed at other institutions. This transfer of graduate credit must be requested from the Graduate College by the student after he or she has satisfactorily completed one semester at the University. A student must take a minimum of 20 units in residence.

Applicants with undergraduate backgrounds in materials science and engineering or in related science disciplines such as chemistry, geology, physics, or other related engineering fields can be admitted to the Master of Science program. Graduate students entering the program from other disciplines should have similar mathematics, chemistry, and physics backgrounds as in the undergraduate curriculum in materials science and engineering. Those students who are deficient in any of these courses should take them after admission to the Master of Science program.

Doctor of Philosophy: A graduate study program will be designed to ensure that each student acquires a thorough understanding of advanced work in the major field as well as in an appropriate minor. The dissertation, based on original research, is expected to represent a distinct contribution to materials knowledge. It should establish the fact that the candidate is capable of independent, original, and creative thinking. It is not necessary that the research be entirely on a scientific aspect of materials, but may include economic and design considerations as well.

As a general policy, applicants with an M.S. degree in materials science and engineering or an allied field, that includes the completion of a thesis, will be admitted to the Ph.D. program. Exceptional B.S. applicants may be admitted directly into the Ph.D. program. Completion of the Ph.D. program requires at least 63 units of graduate courses. These will include (1) 36 units of courses in the major subject (one-half of which must be in regularly-scheduled classes); (2) 18 units of dissertation; and (3) completion of a minor program. Up to 30 units from a completed M.S. degree program may be credited towards the Ph.D. Precise details of the Ph.D. course requirements are available from the department office.

501. Planning for Discovery: Problem Selection and Proposal Preparation (3) I Generation and organization of ideas into an effective research program. Problem selection, research planning, research proposal preparation and presentation. (Identical with ENGR 501)

502. Research Proposal Preparation (3) I Organization and planning of a specific research initiative in consultation with a potential advisor to expedite the selection and definition of a dissertation topic. (Identical with ENGR 502)

503. Applied Surface Chemistry (3) I Fundamentals of surface phenomena, characterization of solid-vapor, solid-liquid and liquid-vapor interfaces, applications in ceramics, electronic and biomedical materials processing, P, a basic course in physical chemistry.


509. Transport Phenomena (3) I Principles of momentum, energy and mass transport, as applied to materials processing, P, 240 MATH 254.


511. Mineral Processing (3) I (Identical with MINE 511)

512. Physical Chemistry of Materials (3) I Physical and chemical topics of interest to material scientists including surface chemistry, electrochemistry and chemical kinetics.

523. Electrochemistry in Materials Science (3) I Principles and applications of electrochemistry in materials science with emphasis on charge-transfer reactions at electrode-solution interfaces; including electrodeposition, electroforming, electrodessplatting. P, 240.

524. Physics and Chemistry of Ceramic Materials (3) II Ceramic crystal structures, crystal chemistry, phase equilibria and sintering theory. P, 260 or consult department before enrolling.

531. Science and Technology of Magnetic Recording Materials (3) I Magnetic properties of materials, materials for magnetic recording, technology of magnetic recording. P, a basic course in chemistry or materials science.

532. Solid-Fluid Reactions (3) I (Identical with CH E 532)


534. Advanced Topics in Electronic Materials (3) I Rpt./2) 1994-95 Topics to be selected from ferroelectrics, opto-electronics, wave guides, and semiconductor materials. (Identical with ECE 534 and OPTI 534)

535. Corrosion and Degradation (3) I The science of corrosion and degradation reactions and its application to engineering problems. P, 331R; 412 or CHEM 480b or CR. (Identical with CH E 535)


554. Design Competition (3) II Students utilize their research experience in formulating and developing a materials design project which they present and defend before a review panel. Team design and research is emphasized.

555. Atomistic Computational Techniques in Materials Science (3) II Monte Carlo and molecular dynamics techniques; classical and quantum dynamical models; application to calculation of materials properties (structural, thermodynamic, transport, electronic properties).

552. Nondestructive Evaluation of Materials (3) II Introduction to the nondestructive testing and evaluation of the various classes of engineering materials. Methods considered include leak detection, penetrant, electromagnetic, radiographic, ultrasonic, electrical, electronic, eddy current, acoustic emission, and thermal. 2R, 3L. P, 331R or 360, or CR.

554. Electronic Packaging Principles (3) I II

555.* Physical Metallurgy and Processing of Metals (3) I Equilibrium and nonequilibrium transformations and phases, effects of alloy elements on important transformations in steel, isothermal transformation diagrams and continuous cooling diagrams. Processing aspects include heat treating, heat transfer during cooling and quenching, segregation effects, and surface hardening techniques. 2R, 3L. P, 331R or 380; 409 or A ME 442.

557.* Integrated Circuit Laboratory (3) I II

559.* Materials Science of Polymers (3) II Introduction to physical properties of polymers. Microstructure, crystallization, rheology, relaxation and mechanical properties.

561.* Biological and Synthetic Materials (3) II 1993-94 Structural materials in biology include fibers (tendon and silk), rubber (elastin), composites (bone) and ceramics (teeth and shells). Their properties are compared with synthetics.

562.* Structure and Properties of Polymers (3) I 1994-95 Topics of intensive current development in polymer science. In each case, the relation between molecular structure, morphology and properties will be explored. Shows how polymers can be designed and tuned to have the properties needed to fulfill specialized functions. Topics include high modulus fibers, nonlinear optical properties, conducting polymers and resins for composite materials.

565.* Microelectronic Packaging Materials (3) I Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered. (Identical with ECE 565)

570.* Technology of Polymers and Ceramics (3) I Processing and properties of glasses and ceramics in a wide range of technological applications. Discussion of patent literature.

571.* The Formation and Structure of Glass (3) I The glass transition, Kauzmann's paradox, kinetic theory of glass formation, physics and chemistry of glass making, glass structure, thermal properties.


579.* Culture and Materials Technology (3) I (Identical with ANTH 579)

580.* Experimental Methods for Microstructural Analysis (3) I II An introduction, through a combination of lectures and laboratory experiences, to both established and new techniques for microstructural characterization of materials.

585.* Technological Forecasting (3) I Introduction to basic forecasting technologies which include causal models, trend extrapolation, growth curves, relevance trees and other models. The role of forecasting in business and government will be discussed. P, MATH 125B or knowledge of calculus.

586.* Technology and Society (3) I The evolution of our technological civilization will be discussed with emphasis on possible future models of technological organizations and on the changing roles of the scientist and engineer.


595. Colloquium
a. Materials (1) [Rpt./5] II

597. Theoretical Thermodynamics of Materials Science (3) I Introduction to classical and quantum statistical thermodynamics as applied to materials science. Electronic properties of metals and semiconductors; phase transformations. P, 510 or other classical thermodynamics course.

Mathematics (MATH)
Mathematics Building, Room 108

602. Modern Methods in Materials Science (2) [Rpt./4 units] II Discussion of several recent theoretical methods or experimental techniques which have been applied to the study of materials. Topics vary from year to year.

652. Statistical Thermodynamics in Materials Science (3) I Introduction to classical and quantum statistical thermodynamics as applied to materials science. Electronic properties of metals and semiconductors; phase transformations. P, 510 or other classical thermodynamics course.

The department offers programs leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees with a major in mathematics. Concentrations are available in pure, applied, or computer mathematics or in probability and statistics. As there are no sharp boundaries between these concentrations, students are encouraged to pursue a broad range of mathematical topics. Programs are planned in consultation with the departmental faculty. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a teaching major in mathematics. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

To be admitted, applicants must have completed the equivalent of an undergraduate major in mathematics with at least fifteen units of upper-division or higher level work including one semester each of advanced analysis at the level of Math. 425, modern algebra at the level of 415, and linear algebra at the level of 413. Applicants are asked to submit scores on the Graduate Record Examination.

Students in master's degree programs are required to pass the Computer Programming examination of the Department of Mathematics as a part of the graduate program.

Degrees
Master of Arts: This program is for students who wish to combine mathematics with some other discipline. The program must include between 9 and 12 units of approved work outside the department. No thesis is required.

Master of Science: This program is for students who wish to concentrate their
graduate credits in mathematics. At least one of
the sequences 511a-511b, 520a-520b, 523a-523b, or 534a-534b is
required, and at most, six units of ap-
proved work outside the department
may be included in the program.

Doctor of Philosophy: The major course
work consists of at least 36 graduate
units. Commonly the minor, consisting
of at least 12 units of approved courses,
is within the department in a concentra-
tion different from the major. A minor
consisting of approved courses outside
the department is also encouraged.
There is a language requirement which
has been satisfied in any two of the follow-
ing: French, German, Russian, or com-
puter programming. The principal com-
ponent of the program is the comple-
tion of a dissertation involving original cre-
ative research. Ph.D. candidates with
other majors who wish to minor in
mathematics are required to take four
graduate level courses in mathematics
and a written examination which covers
the content of those courses.

The faculty of the Department of
Mathematics carries on research (and
research seminars) in a variety of purely
mathematical and interdisciplinary
fields. In algebra and number theory, re-
search includes finite groups, rings, as-
sociative algebras, algebraic number the-
tory, and primality testing. Research in
analysis is being carried out on un-
bounded operators, quantum fields, rela-
tivity, and nonlinear systems of ecol-
ogy, chemistry, and fluid dynamics. In
geometry, there is work on convex sets,
incidence geometry, and fibre bundles;
in probability and statistics, projects in-
volve geostatistics, reliability theory, and
nonparametric estimation. A detailed
summary of faculty research appears
yearly and is available on request.

502.* Mathematical Logic (3) I 1993-94 Se-
tenential calculus, predicate calculus; con-
sistency, independence, completeness, and
the decision problem. Designed to be of interest
to majors in mathematics or philosophy. P, 124 or 125a or PHIL 325. (Identical with C SC 502)

503.* Foundations of Mathematics (3) II 1994-95 Topics in set theory such as functions,
relations, direct products, transfinite in-
duction and recursion, cardinal and ordinal arith-
metic; related topics such as axiomatic sys-
tems, the development of the real number
system, recursive functions. P, 215. (Identical
with PHIL 503)

504.* History of Mathematics (3) I The de-
velopment of mathematics from ancient times
through the 17th century, with emphasis on
problem solving. The study of selected topics
from each field is extended to the 20th cen-
tury. P, 125b.

511a-511b. Modern Algebra (3-3) Structure of
groups, rings, modules, algebras; Galois the-
ory. P, 415 and 416, or 413 and 415.

513.* Linear Algebra (3) II Vector spaces, lin-
ear transformations and matrices, eigen-
values, bilinear forms, orthogonal and unitary

514a-514b. Algebraic Number Theory (3-3)
1993-94 Dedekind domains, complete fields,
class groups and class numbers, Dirichlet unit
theorem, algebraic function fields. P, 511b.

515. Introduction to Abstract Algebra (3) I
Introduction to groups, rings, and fields. P,
323.

516.* Second Course in Abstract Algebra (3)
II A continuation of 515. Topics may include
Galois theory, linear and multilinear algebra,
finite fields and coding theory, Polya enumera-

517a-517b. Group Theory (3-3) 1994-95 Se-
tions from such topics as finite groups, non-
commutative groups, abelian groups, charac-
ters and representations. P, 511b.

518. Topics in Algebra (3) [Rpt./36 units] I II
Advanced topics in groups, rings, fields, al-
gebras; content varies.

519. Topics in Number Theory and Com-
binatorics (3) [Rpt./36 units] I II Advanced
topics in algebraic number theory, analytic
number theory, class fields, combinatorics;
content varies.

520a-520b. Complex Analysis (3-3) 520a: Ana-
yticity. Cauchy's integral formula, residues,
infinite products, conformal mapping, Dirich-
let problem, Riemann mapping theorem. P,
424. 520b: rudiments of Riemann surfaces.
P, 520a or 528.

521.* Fourier Series and Orthogonal Func-
tions (3) I Linear spaces, orthogonal func-
tions, Fourier series, Legendre polynomials and
Bessel functions. P, 254 or 355.

522a-522b.* Advanced Analysis for Engineers
(3-3) Laplace transforms, Fourier series, par-
tial differential equations, vector analysis, in-
tegral theorems, matrices, complex variables.
522a is not prerequisite to 522b. Both 522a and
522b are offered each semester. Not applicable
to M.A., M.S., or Ph.D degrees for math ma-
jors. P, 254 or 355.

523a-523b. Real Analysis (3-3) Lebesque me-
sure and integration, differentiation, Radon-
Nikodym theorem, lp spaces, applications. P,
425.

524.* Elements of Complex Variables (3) III Complex numbers and functions, conformal
mapping, calculus of residues. P, 223.

525.* Real Analysis of One Variable(3) I Con-
tinuity and differentiation of functions of one
variable. Riemann integration, sequences of
functions and uniform convergence. P, 223 and
323.

526. Real Analysis of Several Variables (3) II Continuity and differentiation in higher di-

527a-527b. Principle of Analysis (3-3)
Advanced-level review of linear algebra and
multivariable calculus; survey of real, com-
pact and functional analysis, and differential
geometry with emphasis on the needs of ap-
plicated mathematics. P, 410, 424, and a differen-
tial equations course.

528a-528b. Banach and Hilbert Spaces (3-3)
1994-95 Introduction to the theory of normed
spaces, Banach spaces and Hilbert spaces, op-
erators on Banach spaces, spectral theory of
operators on Hilbert spaces, applications. P,
523a, 527b, or 583b.

529. Topics in Modern Analysis (3) [Rpt./36
units] I II Advanced topics in measure and
integration, complex analysis in one and
differentiable functions, probability, func-
tional analysis, operator theory; content varies.

530.* Second Course in Geometry (3) II
1994-95 Topics may include low-dimensional
geometry; map coloring on surfaces (Hea-
dwood's estimate, Ringel-Young theory), knots
and links or projective geometry. P, 215. Not
applicable to M.A., M.S., or Ph.D degrees in
Mathematics.

534a-534b. Topology-Geometry (3-3) Point set
 topology, the fundamental groups, calculus on
manifolds. Homology, de Rham cohomology,
other topics. Emphasis will be emphasized. P,
415 and 425.

536a-536b. Algebraic Geometry (3-3) 1994-95
Affine and projective varieties, morphisms
and rational maps. Dimension, degree and
smoothness. Basic commutative algebra and Cech cohomology. Line bundles, Riemann-
Roch theorem. P, 511, 520a, 534a.

537a-537b. Global Differential Geometry
(3-3) 1993-94 Surfaces in R3, structure equa-
tions, curvature, Gauss-Bonnet theorem, par-
allel transport, geodesics, calculus of varia-
tions. Jacobi fields and conjugate points,
topology and curvature; Riemannian geom-
etry, connections, curvature tensor, Riem-
nan submanifolds and submersions, sym-
metric spaces, vector bundles. Morse theory,
symplectic geometry. P, 534a-534b.

538. Topics in Geometry and Topology (3)
[Rpt./36 units] I II Advanced topics in point set
general topology, algebraic topology, differen-
tial geometry, content varies.

539. Algebraic Coding Theory (3) II 1993-94
Construction and properties of error correct-
ing codes; encoding and decoding procedures
and information rate for various codes. P, 415.
(Identical with ECE 539)

543.* Theory of Graphs and Networks (3) I
Undirected and directed graphs, connectivity,
circuits, trees, partitions, planarity, coloring
problems, matrix methods, applications in di-
verse disciplines. P, 215 or 223 or 243. (Ident-
ical with C SC 543)

546.* Theory of Numbers (3) I 1994-95 Di-
visibility properties of integers, primes, con-
gruences, quadratic residues, number-

547.* Combinatorial Mathematics (3) II 1994-95 Enumeration and construction of ar-
rangements and designs, generating func-
tions; principle of inclusion-exclusion; recur-
rence relations; a variety of applications. P,
215 or 243.

550. Mathematical Population Dynamics (4)
(Identical with ECOL 550)
555.* Elementary Partial Differential Equations (3-3) 1994-95 Theory and examples of linear equations; characteristics, well-posed problems, regularity, variational properties, asymptotics. Topics in nonlinear equations, such as shock waves, diffusion waves, and estimates in Sobolev spaces. P. 523b or 527b or 583b.


557a-557b. Dynamical Systems and Chaos (3-3) 1993-94 Qualitative theory of dynamical systems, phase space analysis, bifurcation, period doubling, universal scaling, onset of chaos. Applications drawn from atmospheric processes, population ecology, fluid mechanics and optics. P. 422a-422b or 454.

563a-563b. Probability Theory (3-3) 1994-95
563a: Introduction to measure theory, strong law of large numbers, characteristic functions, the central limit theorem, conditional expectations, and discrete parameter martingales. P. 464. 563b: A selection of topics in stochastic processes from Markov chains, Brownian motion, the functional central limit theorem, diffusions and stochastic differential equations, martingales. P. 563a, 468 recommended.

564.* Theory of Probability (3) II Probability spaces, random variables, weak law of large numbers, central limit theorem, various discrete and continuous probability distributions. P. 322 or 323. (Identical with STAT 564)

565a-565b. Stochastic Processes (3-3) 1993-94
565a: Stationary processes, jump processes, diffusions, applications to problems in science and engineering. P. 468.

566a.* Theory of Statistics (3) I (Identical with Stat 566a)


573. Theory of Computation (3) II (Identical with C SC 573)

575a-575b. Numerical Analysis (3-3) Error analysis, solution of linear systems and nonlinear equations, eigenvalues interpolation and approximation, numerical integration, initial and boundary value problems for ordinary differential equations, optimization. P. 475b and 455 or 456. (Identical with C SC 575a-575b)

577. Topics in Applied Mathematics (3) [Rpt./6 units] I II Advanced topics in asymptotics; numerical analysis, approximation theory, mathematical theory of mechanics, dynamical systems, differential equations and inequalities, mathematical theory of statistics; content varies.

581. Case Studies in Applied Mathematics (3-3) I II In-depth treatment of several contemporary problems or problem areas from a variety of fields, but all involving mathematical modeling and analysis; content varies.

587. Perturbation Methods in Applied Mathematics (3) I 1994-95 Regular and singular perturbations, boundary layer theory, multiple and averaging methods for nonlinear waves and oscillators. P. 422a-422b or 454.

595. Colloquium [Rpt.]
595y. Introduction to the Neurosciences I (2) 1991-92 P, consult department before enrolling. (Identical with ANAT 595y, NEUR 595y, PHCL 595y, and Psio. 595y)
595z. Introduction to the Neurosciences II (2) 1991-92 P, 595y or consult department before enrolling. (Identical with ANAT 595z, NEUR 595z, PHCL 595z, Psio. 595z, and PSYI 595z)

596. Seminar Many interdepartmental seminars are numbered at both the 500 and 600 and the 800 levels. See 896 below for a complete listing.

601. Preparation for Clinical Medicine (12) I II P, formal admission to the Ph.D.M.D. program and permission of the course director.

605. Social and Behavioral Science (6) I II P, formal admission to the Ph.D.M.D. program and permission of the course director.

636. Information Theory (3) II 1994-95 (Identical with ECE 636)

667. Theory of Estimation (3) I (Identical with STAT 667)

668. Theory of Testing Hypotheses (3) II (Identical with STAT 668)

697. Workshop a. Problems in Computational Science (3) I II [Rpt./1] (Identical with PHYS 697a)

Mechanical Engineering
(See Aerospace and Mechanical Engineering)

Media Arts
Consult the Department of Media Arts at 621-7352.

Medical Technology
(See Health-Related Professions)

Medicine (MED/ANES/FCM/IMED/NEUR/OBG/OPH/PATHTED/PSYI/FRONC/RADI/SURG)
Arizona Health Sciences Center Room 2208 (602) 626-6518

Interdepartmental (MED)
501. Preparation for Clinical Medicine (12) I II P, formal admission to the Ph.D.M.D. program and permission of the course director.
505. Social and Behavioral Science (6) I II P, formal admission to the Ph.D.M.D. program and permission of the course director.

801. Preparation for Clinical Medicine (12) I II
805. Social and Behavioral Science (6) I II
830. Supplementary Registration (1-9)

896. Seminar a. Introduction to Forensic Pathology (1-3) I II, PATH 801 or permission of instructor.
b. Physical and Biological Basis of Nuclear Medicine (2)
h. Human Sexuality (2)
j. Medical Jurisprudence (2)
k. Cardiovascular Pathophysiology (2)
n.** Research Methods for Clinical and Epidemiological Studies (2) II
s. Salt, Water and Kidney Disorders (2)
t. Pathophysiology of Respiratory Diseases (2)

*Available as both 696 and 896.
** Available as both 596 and 896.

Anatomy
See Anatomy elsewhere in this catalog.

Anesthesiology (ANES)
Professors Burnell R. Brown, Jr., Head, A. Jay Gandolfi, Charles W. Otto, I. Glenn Sipes (Pharmacology and Toxicology)
Associate Professors Randall C. Cork, Stuart R. Hameroff, Stuart F. Quan (Internal Medicine)
Assistant Professor Edward J. Frink

800. Research (1-6) [Rpt./1]
810. Clerkship
a. Anesthesiology (4-6)
815. Subspecialty
a. BNI Neuroanesthesiology (4)
b. Obstetrical Anesthesia (4)
p. Critical Care Medicine (4-6) (Identical with IMED 815p)
891. Preceptorship
a. Anesthesiology and Subspecialties (1-18)

Biochemistry
See Biochemistry elsewhere in this catalog.

Cancer Biology
See Cancer Biology elsewhere in this catalog.

Family and Community Medicine (FCM)
Associate Professors Evan W. Kligman, Head, Jennie Joe, Daniel O. Levinson, Cheryl K. Ritenbaugh, Arthur B. Sanders (Surgery), Catherine M. Shisslak
Assistant Professors Tamsen Bassford, Dorian H. Cordes, Paul R. Gordon, Denise Roe

500. Research (2-16) [Rpt./2]. P, basic science courses.
570. Issues and Trends in Public Health (3) I II S Public health methods; organizations and services such as environmental/occupational health; disease control; health education and promotion; policy and legislation; and medical care.
571. International Comparison of Health Care Systems (3) I II S Comparison of health care systems in developing and industrialized countries in relation to other social systems; public/private component analyses; health care methods and finance.
572. Population Dynamics and Family Planning (3) I II S Social/economic determinants and consequences of population growth; behavioral and health aspects of human reproduction; organization/evaluation of family planning programs.
573. Health Issues of Women and Children (3) I II S Knowledge base, social strategies, health policies and programs relating to health and well-being of women, especially of child-bearing years, and children from infancy to adolescence.
574. Health Administration and Policy (3) I II S Management processes/roles of public health professionals; health service organization; policy issues and resource utilization/control; human resources management; public health trends.
575. Environmental and Environmental Health (3) I II S Examination of living/working environments impacting human health; chemical and physical stressors affecting health; techniques for assessing and controlling risks in air, soil and water.
576. Biostatistics in Public Health (3) I II S Analysis and interpretation of measures of well-being and disease association, disease outbreaks, population surveillance, and health promotion program evaluation.
577. Social and Behavioral Basis of Public Health (3) I II S Social learning theory, diffusion of innovations, relationship of cultural values to behavioral change, social marketing, high risk behavior intervention strategies, and communication issues.
578. Public Health Nutrition (3) I II S Community and individual nutritional assessment; risk profiles; planning, implementing and evaluating programs; international; national and local resources/programs; Healthy People 2000 goals.
587. Poverty and Health (3) I II S (Identical with NURS 587)
588. Clinical Anthropology (3) I II S (Identical with NURS 588)
593. Internship
a. Public Health (1-12)
596. Seminar
a. Occupational Disease (1) II Open to medical or industrial hygiene students only. Consult department before enrolling.
b. Prevention and Control of Disease (1) I Consult department before enrolling.
c. International Nutrition (2-3) II (Identical with N FS 596n)
d. Environmental and Occupational Health (3) II P, permission of instructor.

*May be taken concurrently with 400-level course.

800. Research (2-16) [Rpt./2]
803. Clinical Clerkship (6-9)
811. Subinternship
a. Family Medicine (4-6) I II S
815. Subspecialty
b. The Dying Patient (1-6) [Rpt./1]
d. Problems in Community Oriented Primary Care (6-12)
e. Personal Change in Lifestyle Related Behavior (3-6) Consult department before enrolling.
f. Geriatrics (4-6) [Rpt./6 units] P, third year rotation in FCM and IMED (Identical with IMED 815f, which is home)
h. Cancer Epidemiology and Prevention (3) I P, none; statistics helpful. (Identical with RONC 815h)
i. Cancer Prevention and Control (3-15) II (Identical with RONC 815f)

891. Preceptorship
a. Primary Care (6-12)
b. Family Medicine (3-12) P, 4th year medical students. Consult department before enrolling.
c. Epidemiology at CDC (3) I II P, open to majors in medicine, public health, and nursing. Consult department before enrolling.
d. Rural Care (4-12)
e. Prison Health Care (3-6) Consult department before enrolling.
f. International Health (6-12)
g. AHEC/Border Health (3-12) Consult department before enrolling.
h. Family Medicine Special Studies (4-6) P, completion of basic sciences.
i. Mayo Group Practice (6) P, 4th year medical students.

896. Seminar
a. International Health in the Developing World (3) S Open to health majors only.
b. Approaches to Managing Behavior Problems of Children and Adolescents (2)
c. Leadership Development (2)
d. Principles and Practice of Home Health (2) I II Consult department before enrolling.
e. The Doctor-Patient Relationship (2)
f. Crisis and Conflict: Health Services in Latin America-Brazil (2)
g. Nutrition in Disease (2) [Rpt./1] P, BIOL 801, PSIO 601/801.
h. Practice of Community-Oriented Medicine in Rural Areas (2) II
i. International Nutrition (2-3) II
j. Prepaid Health Care (1) [Rpt./1]
k. Introduction to Public Health (3) I II
l. AIDS, Cancer, Nutrition Immunology (1) II
m. Tropical Disease Problems (2)

** Available as both 596 and 896.

Internal Medicine (IME)
Professors Joseph S. Alpert, Head, David S. Albers, F. Paul Alepa, Robert
f. Geriatrics (4-6) [Rpt./6 units] P, third year rotation in FCM and IMED (identical with FCM 815v) ii

891. Preceptorship
a. General Medicine and/or Subspecialties (3-12) [Rpt./2]

896. Seminar
a. Pathophysiology and Immunology of the Clinical Manifestations of Cocciidiomycosis (2) II

Microbiology and Immunology
See Microbiology and Immunology elsewhere in this catalog.

Molecular and Cellular Biology
See Molecular and Cellular Biology elsewhere in this catalog.

Neurology (NEUR)
Professors Alan B. Rubens, Head, Carol Barnes (Psychology), Peggy Ferry (Pediatrics), Mary I. Johnson (Psychology), William A. Sibley
Associate Professors Colin R. Bamford, William M. Feinberg, Erwin B. Montgomery, Gary Wenk (Psychology)
Assistant Professors Geoffrey L. Ahern, David M. Labiner, Nathaniel T. McMullen (Anatomy), Mark Menne- meier (Psychiatry), Naomi E. Rance (Pathology), Steven Z. Rapcsak, Dinesh Talwar (Pediatrics)

895. Colloquium
y. Introduction to the Neurosciences I (2) 1991-92 P, Consult department before enrolling. (Identical with MED 595y, which is home)

891. Preceptorship
a. Neurology (1-18) [Rpt./2]

Obstetrics and Gynecology (OBG)
Professors M. Wayne Heine, Head, John R. Davis (Pathology), Kenneth Hatch, Jack Pearson, Kathryn L. Reed, John Seeds, Earl A. Surwit
Associate Professors Ponjola Coney, Diane S. Fordney (Psychiatry), Catherine Racowsky
Assistant Professor David G. Chaffin

800. Research (1-18) [Rpt./1] (See College of Medicine Electives Manual.)

803. Clinical Clerkship (6-9)

810. Clerkship
a. Preparation for Practice (4-6)
b. Preparation for Private Practice (3-6) P, 803

811. Subinternship
a. Gynecologic Oncology (3-6) [Rpt./1] P, 803

815. Subspecialty
a. Clinical Incontinence (4-6) I II S
b. Perinatal Medicine (3-6) P, 803

c. High Risk Obstetrics (4-6) P, core Ob/Gyn rotation completed.
d. Gynecology-Endocrinology (3-6)
e. Obstetrical Ultrasound (4-6) P, 803

Ophthalmology (OPH)
Professor Barton L. Hodes
Associate Professor Robert W. Snyder, Head
Assistant Professor Theresa R. Kramer, Joseph M. Miller, Millicent C. Palmer.

800. Research (6-18) I II

815. Subspecialty
a. Ophthalmology (3-6)

891. Preceptorship
a. Ophthalmology (1-18) P. Completion of clinical clerkships.

Pathology (PATH)


Associate Professors James M. Byers III, Ronald B. Schifman, Catherine M. Sper

Assistant Professor Naomi E. Rance

501. General and Systemic Pathology (10) I II P, formal admission to the Ph.D/M.D. program and permission of the course director.

589. *Introduction to Forensic Science: Pathology, Anthropology, Toxicology and Law (2) I II opportunity for the criminal investigator and attorney with an interest in forensic pathology to better understand the results of trauma, toxic substances and environmental catastrophe. Taught off campus only.

*May be convened with 400-level course.

612. Biological Electron Microscopy (4) I (Identical with MCB 612)

801. General and Systemic Pathology (10) I II

810. Clerkship
a. Anatomic Pathology (1-18)
b. Clinical Pathology (1-18)
c. Special Topics (1-18) [Rpt.] P, 801.
d. Anatomic/Clinical Pathology (4-6) P, completion of basic sciences.

891. Preceptorship
a. Pathology (1-18) [Rpt./2]
b. CBI Pathophysiology (4-6) P, completion of basic sciences.

Pediatrics (PED)

Professors Lynn M. Taussig, Head, Leslie L. Barton, Anna I. Binkiewicz, Burris R. Duncan, Robert P. Erickson, Peggy C. Ferry, Stanley J. Goldberg, Ronald Hansen (Internal Medicine), Mary I. Johnson, Otakar Koldovsky, Richard J. Lemen, Elmer S. Lightner, Anthony F. Philippi, Alayne Yates (Psychiatry)

Associate Professors F. Paul Alepa (Internal Medicine), Richard L. Donnerstein, Carlos A. Flores, H. Eugene Hoyme, John J. Hutter, Jr., Wayne J. Morgan, Michael J. Schumacher, Elsa J. Sell, Dan W. Thomas

Assistant Professors Steven H. Erdman, Pamela J. Kling, Daniela Lax, Fabrando D. Martinez, Marc Ovadia, Evelyn D. Rider, Dinesh Talwar, Andrew A. Theodorou, Benjamin S. Wilfond, Jean Wilson (Anatomy), Peter D. Yorgin

800. Research (1-18) (See College of Medicine Electives Manual)

803. Clinical Clerkship (6)

810. Clerkship
b. Inpatient Pediatrics (6)

811. Subinternship
a. Ambulatory Pediatrics (1-18)

815. Subspecialty
a. Advanced Neonatology (4-6)
b. Pediatric Infectious Diseases (3-6)
c. Neurodevelopmental Follow-Up of High Risk Infants (4) P, 803
d. Cardiac Ultrasound Echo and Doppler (4-6)
e. Pediatric Cardiology (4-6)
f. Pediatric Neurology (4-6)
g. Pediatric Hematology/Oncology (4-6)
h. Poison Center (4-6) P, PED 803.

i. Pediatric Pulmonary (4-6) I II P, 803.

j. Clinical Allergy (1-6) (Identical with IMED 815s, which is home)

l. Pediatric Endocrinology (4-6)

m. Pediatric Clinical Research in a Cross-Cultural Setting (4-12) P or IMED 803.


p. Clinical Evaluation and Treatment of Sleep Disorders (3-6) (Identical with IMED 815v)

891. Preceptorship

Radiation Oncology (RONC)

Professors J. Robert Cassady, Head, G. Timothy Bowden, Thomas C. Cetas, Eugene W. Gerber, Robert B. Roemer

Associate Professors Anne E. Cress, Kullervo H. Hynynen, David S. Shimm

Assistant Professor Jesse Martinez, Balblasser D. Stea

501. Radiation Biology (3) II Basic principles of radiation effects in mammalian cell and tissue systems, with emphasis on biochemical aspects, such as DNA damage and DNA repair, and cellular responses, such as cell kinetics defects and radiation repair and recovery: radiation and chemical (especially radiomimetic drugs) carcinogenesis. P introductory biology and chemistry.

505. Eukaryotic DNA Replication (3) [Rpt./1] I 1993-94 (Identical with CBIO 505)

515. Subspecialty
h. Cancer Epidemiology and Prevention (3) I P, none; statistics helpful. (Identical with EPI 515h, which is home)

i. Cancer Prevention and Control (3-15) II (Identical with EPI 515l, which is home)

551. Molecular Mechanisms of Carcinogenesis (3) I 1992-93 (Identical with CBIO 551)

555. Cancer Biology (3) II 1992-93 (Identical with CBIO 555)

595. Colloquium
a. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with CBIO 595d, which is home)
Radiology (RADI)

Professors M. Paul Capp, Head, Harrison H. Barrett (Optical Sciences), Theodore Bowen (Physics), William Dallas, Bruce J. Hillman, Tim B. Hunter (Chief, Diagnostic Radiology), Theron W. Ovitt, Dennis D. Patton (Optical Sciences), Michael J. Pitt (Surgery), Gerald D. Pond, Joachim F. Seeger, William L. Wolfe, Jr. (Optical Sciences), James M. Woolfenden

Associate Professors Raymond F. Carmody, Robert J. Gillies (Biochemistry), Arthur F. Gmitro, Evan C. Unger, Walter H. Williams

Assistant Professors Laurie L. Fajardo, Mark T. Yoshino

Surgery (SURG)


Assistant Professors Bruce L. Dalkin, Michael J. Esser, Allan J. Hamilton, Casey L. Huston, Leigh A. Neumayer, Jon K. Nisbet, Luis J. Rosado-Lopez, Francisco G. Valencia, James A. Warnke, Martin E. Weinand, Craig S. Williams, Fred C. Williams

670. Principles of Perfusion Techniques I (3) I (Identical with PHCL 670)
671. Perfusion Technology Laboratory (1) I (Identical with PHCL 671)
672. Principles of Perfusion Techniques II (2) I (Identical with PHCL 672)

800. Research (1-12) P, 803. (See College of Medicine Electives Manual)
803. Clinical Clerkship (6-9)
807. Specialty Clerkship (3) P, basic science courses.
810. Clerkship
a. General Surgery (6)
b. Burn Care (4-8) P, fourth year medical students or completion of 803.
811. Subinternship
a. Emergency Medicine (4-6) P, 815t.
b. BNI Neurological Surgery (4-6) P, 803.
815. Subspecialty
a. Diagnostic Radiology (4)
b. Nuclear Medicine (1-6)
891. Preceptorship
a. Radiology (1-18) [Rpt./1]
b. Diagnostic Radiology (4) P, completion of basic sciences.

Social Sciences Building, Room 121
(602) 621-1586
Graduate Interdisciplinary Program in Medieval Studies
Committee:
Professors Jonathan Beck (French and Italian), John Boe (Music), Roger Dahood (English), Sigmund Eisner (English), Richard Kinkade (Spanish and Portuguese), Dana Nelson (Spanish and Portuguese), Heiko A. Oberman (History)
Associate Professors Alan E. Bernstein, Chair (History), Carl Berkhout (English), Albrecht Claussen (German), Richard C. Jensen (Emeritus), Peter Medine (English), H. Reynolds Stone (Spanish and Portuguese)
Assistant Professor Cary Nederman (Political Science), Cynthia White (Classics), Jane Williams (Art)

The Graduate Interdisciplinary Program in Medieval Studies does not offer a major at this time. Programs constituting appropriate minors are available for doctoral students with majors in other disciplines. Students interested in the medieval studies minor must secure the approval of the program in advance.

The program of study for the Doctor of Philosophy minor in medieval studies requires: a minimum of fifteen hours in graduate coursework (note that no course may serve a student for both the major and minor); a reading knowledge of either classical or medieval Latin; knowledge of an old form of one language (for language majors, this requirement is in addition to the major field); a course in medieval history or culture such as art (for non-art majors), music
Related Courses

Refer to the appropriate department for course descriptions and unit values. Courses which are applicable to the programs are ARH 412a-412b, 413a, 512a-512b, 519c; LAT 550, 550q; FREN 402, 403, 404, 520, 521; GER 400a, 400b, 511, 512a, 512b; HIST 405a, 405b, 406, 407a, 407b, 408, 500a, 500b; ITAL 422, 520, 527a, 527b, 527c; SPAN 422, 520, 527a, 527b, 527c; RUS 589, 589a, 589b, 589c.

A maximum of six units of 400-level course work may be used in the doctoral minor.

Microbiology and Immunology (MBIM)

Graduate Program
Life Sciences North Room 644 (602) 626-6061

Professors John J. Marchalonis (Head), Harris Bernstein (Chair), Charles P. Gerba (Soil & Water), Marilyn Halonen (Pharmacology), Evan Hersh (Hematology and Oncology), Junetsu Ito, Lynn Joens (Veterinary Science), Margaret Kay, William Meinke, Neil Mendelson (Molecular and Cellular Biology), Ian L. Pepper (Soil and Water Science), Norval Sinclair (Veterinary Science), Glen Songer (Veterinary Science), Charles Sterling (Veterinary Science), Paul Sypherd

Associate Professors Emmanuel Akporiaye, Dominick DeLuca, Richard Friedman, John Galgiani (Medicine), David Harris (Chair, Executive Committee), Mary Hendrix (Anatomy), David Sammons (Veterinary Science), David Yocum (Medicine)

Assistant Professors Rod Adam (Medicine), Raina Miller (Soil & Water)

The graduate program in microbiology and immunology offers research opportunities in all major areas of microbiology and immunology. The research systems used include viruses, viroids, bacteria, bacterial plasmids, fungi, protozoans, parasites, cell and tissue culture, and animal models standardly used in immunological studies.

The department offers the Master of Science and Doctor of Philosophy degrees with a major in microbiology and immunology.

Applicants are required to submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Scores in an advanced section are recommended. At least two letters of recommendation are required for both the M.S. and Ph.D. programs.

501. Medical Microbiology (6) The biological characteristics of microorganisms of importance in human health and disease; the reaction of the host to infectious agents and the mechanisms of host defense; diagnosis and management of infectious disease. Lectures, discussions, and laboratory experiments. P, CHEM 241b.

503R. Biology of Animal Parasites (3) (Identical with V SC 503R) May be convened with MIC 403R.

503L. Parasitology Laboratory (1) (Identical with V SC 503L) May be convened with MIC 403L.

504. Molecular Parasitology (3) II GRD (Identical with V SC 504) May be convened with MIC 404.

505. Eukaryotic DNA Replication (3) [Rpt/1] I 1994-95 (Identical with CBIO 505)

511. Molecular Biology (3) II (Identical with MCB 511) May be convened with MIC 411.


523. Mechanisms of Disease (4) II (Identical with V SC 523) May be convened with MIC 423.


526. Environmental Microbiology Laboratory (2) I (Identical with S W 526) May be convened with MIC 426.

527R. General Mycology (3) I General mycology, with emphasis on the microfungi. P, MIC 205. May be convened with MIC 427R.

527L. General Mycology Laboratory (2) General mycology laboratory, with emphasis on the microfungi. P, 527R or CR. May be convened with MIC 527L.

529. Introductory Virology (3) I Essential features of viruses, and their relationships to the diseases of humans, other animals, plants and microorganisms. P, MIC 205, CHEM 241b, 243b. May be convened with MIC 429.

530. Introduction to Biophysics (2) I (Identical with PHYS 530) May be convened with MIC 430.

531. Biophysical Theory (2) II (Identical with PHYS 531)

538. Ecology of Infectious Disease (3) II (Identical with V SC 538) May be convened with MIC 438.

540. Biodegradation of Pollutants in Soil and Groundwater (3) II (Identical with S W 540) May be convened with MIC 440.

543. Research Animal Methods (3) I (Identical with V SC 543) May be convened with MIC 443.

546. Environmental Biotechnology Laboratory (2) II 1994-95 (Identical with S W 546)

550R. Medical Mycology (2) II The isolation and identification of fungi of medical importance. 6L, P, MIC 205. (Identical with V SC 550R) May be convened with MIC 450R.

550L. Medical Mycology Laboratory (2) II Laboratory experiments dealing with isolation and identification of fungi of medical importance. 6L, P, MIC 205. (Identical with V SC 550L) May be convened with MIC 450L.

551. Molecular Mechanisms of Carcinogenesis (3) I 1994-95 (Identical with CBIO 551)

552. Molecular Mechanisms of Viral Pathogenesis (3) I 1994-95 Review of current concepts in specific areas of viral pathogenesis, including action of exo- and endotoxins, cell surface interactions, phagocytosis and host microbial functions. P, BIOC 460.

555. Cancer Biology (3) II 1994-95 (Identical with CBIO 555)

560. Development of the Immune System (4) II 1993-94 Developmental biology of T cells and B cells. Negative selection (tolerance induction) during the differentiation of T cells and B cells as mediated by T cell receptors and immunoglobulin receptors, respectively. Development of major histocompatibility complex antigen restriction (positive selection)-mediated immune responses and development of T cells in the thymus. (Identical with S W 560) May be convened with MIC 460.

561. Immunobiology (3) II 1994-95 Cells and cellular events involved in humoral and cell-mediated immune responses; morphologic, physiologic and biochemical characteristics of the lymphoreticular system. P, BIOC 462a.

570. Molecular Genetics and Evolution (3) I 1993-94 Molecular genetics and biology of the bacterial viruses; molecular mechanisms of gene regulation, DNA replication, DNA repair, mutation and genetic recombination; current research in bacterial genetics (lysogeny, transduction, conjugation, use of transposons and gene fusions in genetic analysis and transformation); introduction to gene cloning and its uses in analysis of gene structure and regulation. (Identical with GENE 570)


582. Immunotoxicology (2) I (Identical with TOX 582)

589. Cancer Genetics and Cytogenetics (3) I 1993-94 (Identical with CBIO 589)
595. Colloquium
   d. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with CBIO 595d, which is home)

596. Seminar
   a. Current Problems in Molecular Biophysics (1) I II (Identical with PHYS 596a, which is home)

612. Biological Electron Microscopy (4) I (Identical with MCB 612)

630. Experimental Methods for Research (4) II Hands-on techniques necessary for pursuing a research career in Microbiology and Immunology. 12L. P, MIC 419, MBIM 501, 560 or 561, BIOC 460. Consult department before enrolling. (Identical with VSC 630)

672. Food Safety (2) I 1993-94 (Identical with NFS 672)

695. Colloquium
   a. Readings in Microbiology (1) [Rpt.] II
   b. Immunopathology (1) I
   c. Molecular and Cellular Immunology (1) I II
   d. Tumor Virology (1) II
   e. Host-Parasite Interactions (1) [Rpt.] II

696. Seminar
   a. Research (1) [Rpt.] III

801. Medical Microbiology (6) I

851. Molecular Mechanisms of Carcinogenesis (3) II 1993-94 (Identical with CBIO 851)

891. Preceptorship
   a. Microbiology and Immunology (3-12) [Rpt./12 units]

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**Mining and Geological Engineering (G EN/MINEc/MN E)**

Mines Building, Room 229
(602) 621-6063

Professors Jay C. Dotson (Emeritus), De Verle P. Harris, Y.C. Kim, Richard Newcomb, William C. Peters (Emeritus), Michael Rieber
Associate Professors Ben K. Sternberg, Head, Charles E. Glass, Satya Harpalani, Pinnaduwa Kulatilake
Assistant Professors John Kemeny, Douglas LaBrecque, Paul J. A. Lever, Mary Poulton

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in mining engineering, geological and geophysical engineering, and mineral economics. Advanced work in mining engineering is directed toward research and professional development in several fields including mine planning, geomechanics, operations research, robotics, mine health and safety, and the development of new extractive techniques.

Advanced work in geological engineering is directed toward the fields of geophysical engineering, ground stabilization, earthquake engineering, urban planning, remote sensing, and conservation. Mineral economics is a field of applied economics encompassing the interface of minerals engineering and earth sciences with the business of mineral production and the setting of public policy.

Admission to graduate work normally requires the completion of an undergraduate major in these fields, whereas mineral economics students frequently hold bachelor’s degrees in the mineral engineering fields, earth sciences, or in economics. Students with undergraduate majors in other engineering fields or in the physical sciences, however, are encouraged to apply because training in such fields provides an excellent background for approaching some areas of graduate study in this department. The department requires that scores on the Graduate Record Examination be submitted by all applicants for mining engineering and geological engineering.

Students working toward the Master of Science degree in either mining engineering or geological and geophysical engineering will be required to complete a thesis and must pass a final examination covering both the thesis and course work. At least fifteen units of course work must be completed in the major field. A thesis is not required for the master’s degree in mineral economics but is recommended as a desirable element of graduate education and as excellent preparation for studies leading to the Doctor of Philosophy degree. Programs leading to the Doctor of Philosophy degree require completion of at least six units of graduate-level course work in computer science, computer programming, or mathematics. Any questions regarding the qualification of a particular course in satisfying this requirement should be submitted to the department’s graduate committee for clarification. Foreign language competency for doctoral candidates in the Department of Mining and Geological Engineering is not required. Due to the increasingly international nature of engineering and the mineral fields, however, the department recommends that doctoral candidates give serious consideration to developing communication skills in a foreign language.

There are specific course requirements for both the master’s and the doctor’s degrees in all three majors. These requirements along with other policies and procedures are contained in “Guide to Graduate Study,” which is available on request from the Department of Mining and Geological Engineering.

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**Geological Engineering (G EN)**

502. Probability and Statistical Concepts in Geologic Media (4) I Univariate probabilistic and statistical methods: data reduction, basic probability concepts, discrete and continuous probability distributions, sampling distributions, confidence intervals, hypothesis testing, goodness-of-fit tests; applications in geologic media. Introduction to several statistical packages. 3R, 3L. P, MATH 223. (Identical with GEOS 502) Kulatilake

505. Applied Multispectral Imagery (3) II Application of image processing to mineral exploration, engineering geology, groundwater location, and pollution monitoring. P, 407. (Identical with GEOS 505) Glass

507. Photogeology (3) I Use of aerial photographs in geologic mapping. 1R, 6L. P, GEOS 321. (Identical with GEOS 507) Glass

515. Rock Excavation (3) II (Identical with MN E 515)

516. Field Studies in Geophysics (3) II S Seismic, magnetic, electrical, and gravity exploration techniques. Field trips. Special fee may be required. P, 448 548. (Identical with GEOS 516) Sternberg

522. Well Logging Interpretation (3) II Basic well logging theory. Fundamentals of quantitative formation evaluation. Detailed investigation of aspects of well logging applicable to student’s research interests. P, consult department before enrolling. (Identical with GEOS 522 and HWR 522) LaBrecque


525. Geotechnical Investigations (3) II Investigation and analysis of geotechnical factors in the design and construction of engineering projects. 1R, 6L.

526. Health and Safety in Mining (1-2) I (Identical with MN E 526)

527. Geomechanics (3-4) I (Identical with MN E 527)

537. Developments in Rock Mechanics (2) I (Identical with MN E 537)

545. Fundamentals of Geostatistics (3) [Rpt./6 units] II (Identical with MN E 545)

548. Geophysical Exploration and Engineering (3) I Principles of gravity, magnetic, and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources. 3R, 4L. P, PHYS 110, 116, MATH 223. (Identical with GEOS 548) Sternberg/Johnson


550. Earthquake Engineering (3) I Applied course in earthquake causes and effects, integrating the fields of seismology, engineering, and seismic geology. P, MATH 254. Glass
557. Fundamentals of Geomechanics (4) II (Identical with MN E 527)

560. Electrical Exploration Methods (3) I Electrical properties of minerals and rocks, resistivity and resistivity exploration, induced polarization and complex resistivity, magneto-telluric methods, and electromagnetc prospecting methods. P, 448. Consult department before enrolling. (Identical with GEOS 560) Sternberg

570. Computer Methods in Engineering (3) II Use of computers to solve problems in geological engineering, including data bases, computer contouring, map filtering and enhancement, and multivariate analysis of geologic data. P, introductory courses in computer programming, math, and earth science. Poulson/Sternberg

580. The Mechanics of Fracture in Rock and Other Brittle Materials (3) II (Identical with MN E 580)

587. Applied Neural Network Computing (3) II Theoretical development and applications of artificial neural networks for classification, parameter estimation, prediction, filtering, and association. Emphasis is placed on applications in science and engineering. P, knowledge of a programming language. Poulson

590. Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

*May be converted with 400-level course.

603. Rock Mass Joint Geometry Modeling (3) I 1993-94 Sampling techniques; statistical homogeneity; delineation of joint sets; corrections for sampling biases of joint parameters; inference of statistical distributions for orientation, spacing, intensity and size; joint system modeling and validation. 2R, 3L, P, 402, SIE 270. Kukalalale

629. Rock Slope Analyses and Design (3) I (Identical with MN E 629)

649. Probabilistic Methods in Geotechnical Engineering (3) II (Identical with C E 649)

660a-660b. Estimation of Mineral Resources by Quantitative Methods (3-3) (Identical with MNEC 660a-660b)

696. Seminar

a. Research (1-3) [Rpt.] I II (Identical with MN E 696a and MNEC 696a)

Mineral Economics (MNEC)


518.* Mine Investment Analysis (3) II (Identical with MN E 518) Harris


584. Economics of Fossil, Fissile, and Alternative Energy Sources (3) I Reserves and resources; economics of production, utilization and conversion, uranium, coal, and nuclear power. P, AREC 504. Rieber/Newcomb


*May be converted with 400-level course.

600. Readings in Mineral Economics (3) II Selected readings in the economics of mineral resource exploration and exploitation, environmental protection, national mineral policy, world mineral development, and international trade. P, ECON 361. Rieber

650a-650b. Advanced Principles of Mineral Economics (3-3) Risk analysis; optimum production, depletion and exhaustion; productivity and technical change; imperfect competition in mineral markets; resource distribution, trade and mineral policy. P, ECON 501a or AREC 504. Rieber/Newcomb

560. Electrical Exploration Methods (3) I Reserves and resources; economics of production, utilization and conversion, uranium, coal, and nuclear power. P, AREC 504. (Identical with G E 527)

501.* Analysis of Mine Operations (3) I Use of operations research principles and techniques to analyze various problems in mine operations. Harpalani

502.* Probability and Statistical Concepts in Geologic Media (4) I (Identical with G E 502)

503. Analysis of Mining Decisions (3) I Use of geostatistics, system simulation languages and computers to analyze various mining decisions related to reserve estimation and mine planning. P, 401, 402, 430. Kim

506.* Fundamentals of Mine Ventilation (3) II Determination of quality and quantity of respirable air in mining operations. Thermodynamics of mine ventilation and design of ventilation systems. 2R, 3L, Harpalani

511.* Mineral Processing (3) I Physical and chemical unit operations used to separate and recover the economic minerals and metals from their ores. The modern scientific and engineering background for the operations are presented as well as economic aspects. Includes field trips to major mining operations in Tucson area. (Identical with MBE 511)

515.* Rock Excavation (3) II Methods of excavation of rock in surface and underground mines and construction, ranging from the empiricism of conventional blasting practice to the application of the fundamental mechanisms of rock fracture. 2R, 3L. Field trips. P, C E 217. (Identical with G E 515)

518.* Mine Investment Analysis (3) II Economic factors, including taxation, mineral depletion allowance, and finance in the mining industry; includes fundamentals of engineering economics, capital budgeting, and risk analysis. P, 430. (Identical with MNEC 518) Harris

526.* Health and Safety in Mining (1) I Fundamental concepts in the recognition, evaluation and control of health and safety hazards encountered in industrial operations; includes a review of engineering and plant management responsibilities to control accidents, a review of federal regulations and standards affecting the industrial workplace, and instruction regarding the interaction of industrial hygiene, safety, fire protection and workers' compensation to control losses resulting from industrial accidents. (Identical with G E 526)

527.* Geomechanics (3-4) I Mechanical behavior of rock and rock masses; response to load changes: deformations, failure, discontinuity slip; in situ stress state; rock testing; geomechanical classifications; engineering applications: slopes, pillars, tunnels, dam foundations; reinforcement design. 3R, 3L, P, C E 217, GEOS 321. (Identical with G E 527) Kemna

530.* Mine Examination and Valuation (3) I Principles and procedures in mineral property valuation, geostatistical ore reserve estimation, engineering, economy, investment
analysis; use of a microcomputer. P, 402, 220.

Kim

533. Elements of Coal Mining (3) Coal geology, properties and use. Surface and underground methods and equipment: strip mining; continuous, conventional, longwall mining; ground control; ventilation; haulage; electrical power; drainage. Preparation and reclamation. P, 220, 406, ECE 207.

535. Mine Design (3) II Computer-aided design of a modern mine; feasibility study, pit limit design, mining sequence development and short-term mine planning. 2R, 3L. P or CR, 430, 440. Kim

536. Subsurface Environmental Engineering (3) I Analysis of sources of heat, humidity, gases and dust in mines and other subsurface facilities. Design of engineering systems to control these pollutants. P, 406 or consult with department before enrolling. Harpalani


596. Seminar

a. Research (1-3) [Rpt.] I II (Identical with G EN 696a, which is home)

Molecular and Cellular Biology (MCB)

Life Sciences South Building, Room 444
(602) 621-7560

Professors Samuel Ward, Head, H. Vasken Apooshian, Hans Bohnert (Biochemistry), Don Bourque (Biochemistry), George T. Bowden (Radiation Oncology), Robert P. Erickson (Pediatrics), Wayne R. Ferris (Emeritus), William J. Grimes (Biochemistry), Mac E. Hadley (Anatomy), Richard B. Hallick (Biochemistry), John Hildebrand (Arizona Research Laboratory), Henry Koffler (Biochemistry, Microbiology and Immunology), Brian Larkins (Plant Sciences), John Little (Biochemistry), Neil H. Mendelson, David W. Mount, Gene Myers (Computer Science), Nobuyoshi Shimizu, Paul Sypherd, Hans Van Etten (Plant Pathology)

Associate Professors Danny Brower, Gail Burd (Anatomy), Carol Dieckmann (Anatomy), Lynn Manseau, Roger L. Miesfeld (Biochemistry), Karen Oishi, Roy Parker, Mary Rykowski (Anatomy), Scott Selleck (Arizona Research Laboratories), Ted Weinert

The University Department of Molecular and Cellular Biology is a research-oriented department in which students may receive advanced training in all aspects of research which employ cellular, molecular, biochemical, and genetic approaches. The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in molecular and cellular biology. Except in unusual circumstances, the department will only admit graduate students whose stated objective is the Doctor of Philosophy degree.

Applicants for admission should be prepared in chemistry, physics, and mathematics in addition to biology and must submit scores on the aptitude tests of the Graduate Record Examination. Applicants must communicate directly with the department regarding other admission requirements. The deadline for completion of all application files for admission to the programs beginning with the fall semester is April 1 (March 15 for applicants desiring financial assistance).

Students are expected to specialize in areas of interest to the faculty. These include viral oncology, regulation of gene expression, neurobiology of simple systems, cellular ultrastructure and function, stereochemistry and function of nucleic acids, developmental biology of higher plants, plant molecular biology, molecular genetics, invertebrate developmental genetics, and yeast molecular biology. A listing of the faculty of the department and their research interests can be obtained from the department on request.

501. Molecular and Cellular Biology (4) I P, formal admission to the Ph.D./M.D. program and permission of the course director.

505. Eukaryotic DNA Replication (3) [Rpt.] I 1994-95 (Identical with BIOC 505)

510. Plant Molecular Biology (3) II 1994-95 (Identical with BIOC 510)

511. Molecular Biology (3) II Mechanisms of genome replication, genetic recombination, DNA repair, gene expression and regulation. P, 181, BIOC 462a (Identical with BIOC 511 and MBIM 511) Consult department before enrolling. MCB majors should not take this course for graduate credit.

513. Somatic Cell and Molecular Genetics Laboratory (3) I Modern lab. techniques for genetic and molecular analyses of mammalian cells in culture. 6L. P, CR 181.

515. Somatic Cell and Molecular Genetics (2) II Modern concepts of eucaryotic cell genetics and molecular mechanisms of cell growth control. P, 181. (Identical with BIOC 515)

516. Computer Analysis of Sequences (3) II Analysis of protein and DNA sequence information using computer methods. Before enrolling, consult instructor for appropriate prerequisites (Identical with BIOC 516, ECOL 516 and GENE 516)

520. Pathways and Signals in Cells (3) II (Identical with BIOC 520)

543. Insect Neurobiology (3) II (Identical with ENTO 543)

545. Concepts in Genetic Analysis (3) I Methods of genetic analysis including mutant isolation, genetic and physical mapping, re-
verse genetics, evolutionary mechanisms, molecular variation and genomic evolution. P, introductory undergraduate genetics course or biology course. (Identical with BIOC 545, ECOL 545, GENE 545)

550. Topics in Pigment Cell Biology (2) I (Identical with ANAT 550)

555. Molecular Mechanisms of Development (3) II Detailed examination of molecular, genetic and cellular approaches to selected problems in developmental biology. P, 545, 568 or consult department before enrolling. (Identical with BIOC 555 and GENE 555)

556. Developmental Biology (3) I (Identical with ANAT 556)

557. Experiments in Developmental Biology (4) II (Identical with ANAT 557)

558. Advanced Subjects in Endocrinology (2) [Rpt. /1] (Identical with ANAT 558)

560. Plant Physiology (4) I (Identical with PL S 560)

562. Plant Intermediary Metabolism (3) II 1993-94 (Identical with PL S 562)

564. Plant Growth and Development (3) II 1993-94 (Identical with PL S 564)

566. Physiology Laboratory (2) II (Identical with ECOL 566)

567R. Endocrinology (3) II (Identical with ANAT 567R)

568. Nucleic Acids (4) I (Identical with BIOC 568)

569. Topics in Gene Regulation (2) II 1994-95 (Identical with BIOC 569)

571. Human Embryology (4) II (Identical with ANAT 571)

572. Biological Regulation (4) I (Identical with BIOC 572)

574. Advances in Mammalian Genetics (2) [Rpt. /1] 1994-95 (Identical with BIOC 574)

577. Principles of Cell Biology (4) II (Identical with ANAT 577)

582. Topics in Neural Development (2) II 1993-94 (Identical with NRSC 582)

583. Topics in Neural Plasticity (2) II 1993-94 Reading and discussion of primary literature on cellular, biochemical, physiological, and structural changes that occur on the adult nervous system. P, a course in neurobiology, consult department before enrolling. (Identical with ANAT 583 and NRSC 583)

584. Cellular Neurobiology (2) II 1993-94 (Identical with ANAT 584)

586. Intracellular Messengers (2) I 1993-94 (Identical with NRSC 586)

587. Biology of Neurological Disease (3) II 1993-94 (Identical with NRSC 587)

588. Principles of Cellular and Molecular Neurobiology (4) I (Identical with NRSC 588)

589. Cancer Genetics and Cytogenetics (3) I 1993-94 (Identical with CBIO 589)

595. Colloquium
a. Topics in Molecular Biology (1) [Rpt. /6] I II Open to majors only.

596. Seminar
b. Concepts in Cellular Differentiation (2) I (Identical with ANAT 596c)

597. Workshop
a. Recombinant DNA Techniques (2) S (Identical with BIOC 597a, which is home)

*May be convened with 400-level course.

601. Molecular and Cellular Biology (4) I Acquire a basic understanding of modern genetics, molecular biology, and cell biology, and learn how to apply that understanding to human disease. (Identical with GENE 601) P, consult department before enrolling.

612. Biological Electron Microscopy (4) I Provides theoretical background and practical experience in transmission and scanning electron microscopy that are necessary for the efficient and effective application of ultrastructural and cytochemical techniques as research tools. 2R, 6L. P, one college level course in each of physics, chemistry and biology. (Identical with ANAT 612, AN S 612, BIOC 612, ENTO 612, MBIM 612, PATH 612, PSIO 612, PL P 612, V SC 612)

621. Molecular, Plant, Microbe Interactions (3) II 1994-95 (Identical with PL P 621)

695. Colloquium
a. Current Topics in Plant Biology (2) [Rpt. /3] I II (Identical with PL P 695a, which is home)

696. Seminar
a. Developmental Biology (1) [Rpt. /6] I II To be taken only when 596a repeated course limit has been met.

761. Laboratory Rotation I (2) I II [Rpt. /1] Research project with graduate faculty for 8 weeks, 15 hours per week. Open to majors only.

762. Laboratory Rotation II (2) I II [Rpt. /1] Research project with graduate faculty for 8 weeks, 15 hours per week. Open to majors only.

763. Laboratory Rotation III (2) I II Research project with graduate faculty for 8 weeks, 15 hours per week. Open to majors only.

801. Molecular and Cellular Biology (4) I Freshman medical students only.

Music (MUS/MUSI)

Music Building, Room 109
(602) 621-1655

Professors Dorothy K. Payne, Director, James R. Anthony (Emeritus), John Bloom (Emeritus), John Boe, Andrew Buchhauser (Emeritus), Edna Church (Emerita), Gary D. Cook, Larry J. Day, Gordon Epperson (Emeritus), Billie R. Erlings, Thomas Ervin, Richard Faith (Emeritus), John R. Ferrell (Emeritus), Gregg I. Hanson, O. M. Hartsell (Emeritus), Jeffrey Haskell, Steven Hedden, Robert Hull (Emeritus), Henry Johnson (Emeritus), Roy A. Johnson, Jean-Louis Kashy, Jack Lee (Emeritus), Robert Mc Bride (Emeritus), Elizabeth Mosher, Robert Muczyński (Emeritus), Edward W. Murphy, James P. O'Brien, Margarette Ough (Emerita), Leonard A. Pearlman, Richard E. Peters (Emeritus), Jocelyn Reiter, Charles Roe, Anita Sammarco (Emerita), Anna Mae Sharp (Emerita), Maurice Skones (Emeritus), R. Warren Sutherland, Nicholas L. Zumbro


Assistant Professors John T. Brobeck, Enrique Feldman, Patrick Neher, Gary B. Wilson

The school offers a program leading to the Master of Music degree with majors in composition, music education, musicology, music theory, and performance. The school also offers a program leading to the Doctor of Musical Arts degree with majors in composition, conducting, and performance. With the doctoral performance major, concentrations are available in bassoon, cello, clarinet, flute, guitar, horn, harp, organ, percussion, piano, saxophone, string bass, trombone, trumpet, viola, violin, and voice. A reading proficiency examination in either German, French or Italian will be required for the Doctor of Musical Arts degree with the major in performance and concentration in voice. The school also offers programs leading to the Doctor of Philosophy degree with majors in music theory or music education. All candidates for admission to the Ph.D. program with a major in music theory will show evidence of satisfactory competencies in their field of concentration. There are two minors, one in music with a minimum of nine units and one in a field outside of music, also with a minimum of nine units. German and French are the required languages for this degree. The event a candidate works in a field of specialization that warrants it, another language, such as Greek, Latin, or Italian, can be substituted for French with the permission of the School of Music Graduate Committee. If the research specialization lies
within a computer-assisted field, expertise in that technology can be substituted for French. Applicants for the Ph.D. program in music education will be required to furnish evidence of at least three years of successful teaching or administrative experience in the field of music whether in the public schools or at the college level. Additional details regarding the doctoral program in music education are available from the Director of Graduate Studies in Music. For further information concerning these degrees see Requirements for Master's Degrees/Master of Music and Requirements for Doctor's Degrees/Doctor of Musical Arts and Doctor of Philosophy elsewhere in this catalog.

Applicants are required to audition by personal interview or by submitting a tape recording. Beginning graduate students must take placement tests in music theory and in music history/literature. Doctoral students are not admitted to a particular curriculum until they have passed a qualifying examination administered each semester by the School of Music. Admission is limited to applicants who exhibit superior musical aptitude and training and who show continued growth in their chosen fields of music.

510a-510b. Pedagogy (2-2) Study of methods and repertory suitable for studio teaching. Open to music majors in their major performance area only.

518. Band Arranging (2) II 1994-95 Detailed study of band instrumentation; major works transcribed for concert band. P. 421.

520a-520b. Counterpoint (3-3) Practical study of the counterpoint of the 16th (in 520a) and 18th (in 520b) centuries. P. 220b.

521. Introduction to Graduate Music Theory (3) II Introduction to graduate analysis with emphasis on the survey of analytical systems as applied to a number of stylistic periods. Both cognitive and aural procedures will be investigated. This course may not be used to fulfill doctoral requirements in music. Open to majors only.

522a-522b. Art Song Repertory (2-2) 1994-95 Class performance of representative selections from the standard repertory of German, Italian, French, and English language art songs; problems of accompaniment, interpretation, style and ensemble. Registration restricted to singers and pianists. Open to majors only.

523a-523b. History of the Opera (3-3) 1993-94 Detailed study of the course of opera from its inception by the Florentine Camerata through Berg, Menotti, Stravinsky, Ginastera, Penderecki, Britten and others. Open to majors only.

524. History and Literature of Guitar (3) II 1994-95 In-depth study of the evolution of the guitar, lute, and vihuela, including repertoire, style periods, and composers. Open to majors only.

525. History and Literature of the Wind Band (3) A research-oriented study of wind band history and literature from the Renaissance to the present.

526a-526b. Piano Literature (3-3) 1994-95 Historical and stylistic study of keyboard literature, instruments and performance practices. P. 285P-526a is not prerequisite to 526b.

530. Music in the Renaissance (3) II 1994-95 Vocal and instrumental genres from Dufay through Palestrina. Open to majors only.

531. Music in the Baroque (3) II 1993-94 The baro-no-continen; instrumental and vocal genres from Monteverdi through J. S. Bach. Open to majors only.

532. Music in the Classical Period (3) I 1994-95 The Viennese classical tradition from its origins to Beethoven. Open to majors only.

533. Music of the Twentieth Century (3) I Contemporary idioms in music; study of genres, styles, and techniques from post-Romanticism to the present. Open to majors only.


541. Electro-Acoustic Music (3) I Comprehensive study of electronic music. Introduction to the electronic music studio, tape composition, acoustics, music synthesis and sound processing, with actual lab applications.

542. Electro-Acoustic Studio Resources (3) II Advanced techniques: synthesis, processing, synthesizer programming, sampling, MIDI, computer-assisted techniques, sequencing and notation.

550. Advanced Studies in Music Teaching (3) II S Contemporary practices in planning, organizing and evaluating learning experiences in music for K-12 students.

551. Behavioral Research in the Arts (3) I S 1993-94 Research methodologies as they apply to artistic behavior; emphasis on applying the results of existing studies to practice and on conducting original research.

555. Music and German Literature (3) I 1994-95 (Identical with GER 555)

560. Aesthetics of Music (3) I Exploration of the problems of musical meanings, including a panoramic examination of what philosophers, philosophic musicians and artists, and others of critical intelligence have contributed to comprehensive theory.

570. Advanced Conducting (3) [Rpt.] II Styles of choral, band, and orchestral literature, as they pertain to the problems of the conductor; references to the styles of all periods, with emphasis on the contemporary and modern.

597. Workshop a. Level I Orff Schulwerk (2) S *May be convened with 400-level course.

600. Introduction to Graduate Study in Music (3) I Bibliographical materials; research resources, techniques, and problems directed toward graduate study in music. Required of all doctoral candidates in music. (Identical with LIS 600)

620a-620b. History of Speculative Theory (3-3) II 1993-94 Survey of speculative theory in music, classical Greeks to present.

621a-621b. Analysis of Music of the 18th and 19th Centuries (3-3) Intensive analysis of works written in the larger forms. 621a: 18th century. 621b: 19th century. Open to majors only. 621a is not prerequisite to 621b.

622. Theory Pedagogy (3) I 1994-95 Study of the philosophies, procedures, techniques, and materials used in teaching theory at the college level.


630. The Music of Bach (3) II 1994-95

631. The Music of Mozart (3) S 1993-94

632. The Music of Beethoven (3) S 1993-94

633. Music of the Twentieth Century (3) I 1993-94

640. History of Musicology (1-6) [Rpt./9 units] I II Survey of musicology from the Baroque to the present.

650. Foundations and Principles of Music Education (3) I S History and philosophy of music education. No more than 12 units of this course may be applied to a graduate degree program.

651. Curriculum Development in Music (3) II S 1994-95 Principles and techniques of curriculum construction applied to the field of music.

652. Management Techniques in Music (3) II 1994-95 The management of music at all levels of education, industry, and performance.

654. Psychology of Music (3) S 1994-95 Music perception, physiological and psychological responses to music; basic acoustics, music pedagogy, and evaluation/measurement of music behaviors.

672. Teaching Music in Higher Education (3) II 1993-94 Contemporary practices in planning, organizing, and evaluating learning experiences in music for college and university students. Open to music majors only.

696. Seminar a. Music Education (1-6) [Rpt./9 units] I II b. Musicology (1-6) [Rpt./9 units] I II
see schedule of fees below.

All of the courses listed below are offered both first and second semesters and may be repeated. Prerequisite for entrance to all ensembles is by audition or by permission of the School of Music.

### 500. Large Conducted Ensembles (1)
- Marching Band
- Concert Band
- Symphonic Band
- Wind Symphony
- Summer Chorus
- Symphonic Choir
- University Singers
- Chamber Choir
- Chorale
- Symphony Orchestra
- Collegium Musicum
- Jazz Ensemble
- Honor Choir

### 501. Coached Ensembles (1)
Offering chamber music experience; designed to develop musical independence.
- Accompanying
- Brass Ensemble
- Percussion Ensemble
- Guitar Ensemble
- Jazz Combo
- Saxophone Ensemble
- String Ensemble
- Woodwind Ensemble
- Steel Band
- Mariachi Arizona
- Electronic Music Ensemble

### 502. Small Conducted Ensembles (1)
- Brass Choir
- Contemporary Ensemble
- Clarinet Choir
- Musical Theatre
- Pep Band
- Flute Choir
- Recital Choir
- Trombone Choir

### 605. Opera Theatre (1-4)
Training in all aspects of operatic production, including major singing roles, minor roles, opera chorus, opera scenes and chamber operas; technical training in set construction, makeup, costumes and lighting. 605 may also include opera staging techniques. P. 4 units of 405 or permission of the School of Music.

### Composition Studies: Individual and Group Instruction
- Advanced Composition (2-6) [Rpt/9 units] I II
- Piano Accompanying 685-W (1-4)
- Voice 580-V (1-2); 585-V (1-4)
- Vocal Coaching 685-J (1)
- Organ 580-O (1-2); 585-O (1-4)
- Conducting 585-Q (1-4); 685-Q, 785-Q (1-4)
- String Bass 580-N (1-2); 585-N (1-4)
- Violin 580-K (1-2); 585-K (1-4)
- Cello 580-M (1-2); 585-M (1-4)
- Harp 580-H (1-2); 585-H (1-4)
- Guitar 580-G (1-2); 585-G (1-4)
- Violin 580-L (1-2); 585-L (1-4)
- Harpsichord 580-I (1-2); 585-I (1-4)
- Wind Instruments
  - Baritone 580-E (1-2); 585-E (1-4)
  - Bassoon 580-B (1-2); 585-B (1-4)
  - Clarinet 580-C (1-2); 585-C (1-4)
  - Flute 580-F (1-2); 585-F (1-4)
  - Horn 580-D (1-2); 585-D (1-4)
  - Oboe 580-A (1-2); 585-A (1-4)
- Saxophone
  - Saxophone 580-S (1-2); 585-S (1-4)
  - Trombone 580-R (1-2); 585-R (1-4)
- Trumpet 580-T (1-2); 585-T (1-4); 685-T, 785-T (1-4)

### Music Fees
All students registering for private or group instruction are charged special fees according to the following schedule. Regular and scholarship students will be assigned to private or group instruction each semester only after a Music Fee Statement has been secured. Rental instruments, practice rooms and lockers are issued upon presentation of this statement.

- Group lesson or one-half hour private lesson: $40.
- One-hour private lesson: $60.

A music major registering for more than one weekly lesson will pay a maximum fee of $60.

### Rentals
Instruments are rented as available for use in regularly scheduled music activities according to the following fee schedule. Any damage beyond normal wear and tear will be paid for by the renter of the instrument. All rental instruments must be returned by the end of the semester or on demand.

**Practice Room and Piano Rental:** Pianos will be rented only to those enrolled in group, private instruction or keyboard class. $5 for one hour practice per day. $10 for two hours practice per day. $15 for three hours practice per day.

**Organs, Harpsichords, and Synthesizers:** $10 for one hour practice per day. $15 for two hours practice per day. $20 for three hours practice per day.

**Harps:** $20 for one hour practice per day. $25 for two hours practice per day. $30 for three hours practice per day.

**Band and Orchestra Instruments:** Rented only to those enrolled in ensembles or techniques and literature classes. $10 per semester.

Refunds will be made according to the refund schedule. No refund will be made on rental charges of $5 or less.

### Near Eastern Studies (NES/ARB/PRS)
Franklin Building, Room 403 (602) 621-8013
Professors William G. Dever, Head, Ludwig A. Adamec, Michael E. Bonine, Adel S. Gamal, J. Michael Mahar, Hamdi A. Qafisheh
Associate Professors Esther Fuchs (Judaic Studies), William J. Wilson
Assistant Professors Simin Karimi, Senzil Nawid

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Near Eastern studies. Instruction is available in the languages, cultures, and civilizations of the Middle East and the Ancient Near East. Concentrations are available in language and literature, history, thought, and society (either ancient or modern) of these areas. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in Near Eastern studies. For information concerning this degree, see Requirements for Master’s Degrees/Master of Education elsewhere in this catalog.

Applicants must forward to the head of the department scores on the aptitude test of the Graduate Record Examination and two letters of recommendation from previous instructors or academic advisors. Students without previous disciplinary or language training related to the Middle East may be required to make up deficiencies without graduate credit.

Degrees

Master of Arts: Requirements include 30 units of course work with a thesis or, when a departmental paper is submitted in lieu of thesis, no fewer than 32 units. Two degree plans are available in consultation with an advisor: (1) a non-specialist terminal program, multi-area if desired, and (2) a specialist program requiring a minimum of two years of an appropriate language. The specialist program normally requires three or more semesters and often serves as preparation for the Doctor of Philosophy degree program.

Doctor of Philosophy: This program requires completion of the Master of Arts degree (specialist program) or equivalent training plus those additional courses in the major and minor areas selected by the student’s guidance committee.

Arabic (ARB)


504. * Advanced Arabic II (3) Emphasis on oral and written comprehension and expression. P, 403 or 503.


526. * Introduction to Arabic Linguistics (3) II History and structure of the Arabic language in its various forms. P, 102, LING 101. (Identical with LING 526)

539a-539b. * Egyptian Arabic (3-3) Introduction to the Cairene dialect. Phonology, common greetings, basic vocabulary and grammar. P, one year of Standard Arabic.

548. * Arabic Literature in English (3) Historical survey of Arabic literature of the Middle East and Mediterranean world, with readings in English translations.

595. Colloquium
   b. * Classical Arabic Prose (3) [Rpt. ] P, two years of Arabic.
   c. * Readings in Classical Arabic Poetry (3) S, P, three years of Arabic for non-native speakers of Arabic.

Persian (PRS)

504. * Advanced Persian I (4) CDT Readings in Persian, with the objective of preparing the student for independent research. P, 402.

505. * Advanced Persian II (4) CDT Readings in Persian, with the objective of preparing the student for independent research. P, 404.

549. * Classical Persian Literature in English (3) II Historical, cultural, and literary issues related to the readings will be discussed.

550. * Contemporary Persian Literature in English (3) Historical, cultural and literary issues related to the readings will be discussed.

Near Eastern Studies (NES)

501. * Ancient Mesopotamia (3) I (Identical with ANTH 501)

503b. Introduction to Comparative Literature and Literary Theory (3) II (Identical with CCLS 503b)

509a-509b. * Biblical Hebrew (3 to 4—3 to 4) 1994-95 Study of Biblical Hebrew grammar and literature. 509a: Prose texts. 509b: Poetry. (Identical with JUS 509a-509b)

534. * Islamic Thought (3) II Traditional ideological systems of Islamic countries and their evolutionary transformations.

535. * Jewish Mysticism (3) II 1993-94 (Identical with JUS 535)

537a-537b. Readings in Akkadian (3-3) (Identical with ANTH 537a-537b)

540. Linguistic Change and Diachronic Theory (3) II (Identical with LING 540)

542. * Transformation of Agrarian Societies in the Middle East (3) II Dynamics, processes, and implications of rural change in the Middle East; focus on changes in peasant communities, nomadic pastoralists, rural-urban relations, and planned change. (Identical with POL 542)

557. * Prehistoric Mesopotamia (3) I (Identical with ANTH 557)

567. Population Development in the Middle East (3) I Review of theories and research in population, resources and socioeconomic development, with emphasis on determinants and consequences of population growth and migration in contemporary Middle East. (Identical with POL 567)

568a-568b. * Asia and the West (3-3) 1993-94 (Identical with HIST 568a-568b)

570. * Religious History of India (3) (Identical with HIST 570)

572. * History of Medieval India (3) I 1993-94 (Identical with HIST 572)

573. * History of Modern India and Pakistan: 1750—Present (3) II 1993-94 (Identical with HIST 573)

577a-577b. * History of the Middle East (3-3) History of civilization in the Middle East from the rise of Islam to the 18th century. 577a: Period of Arab dominance. 577b: Period of Turkish dominance. 577a is not prerequisite to 577b. (Identical with HIST 577a-577b)

578. * Modern History of the Middle East (3) I Near and Middle Eastern history since the late 18th century, with special emphasis on Egypt and areas to the east. (Identical with HIST 578)

581a-581b. * Archaeology of Syria-Palestine in the Bronze and Iron Ages (3-3) Survey of the Bronze and Iron Age cultures of Syria-Palestine, ca. 3500-500 B.C., with emphasis on the use of archaeological materials in historical reconstruction.

584a-584b. * Akkadian Linguistics (3-3) (Identical with ANTH 584a-584b)

585. * Social Organization of India and Pakistan (3) I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with ANTH 585)

586. * Political Systems of India and Pakistan (3) II Survey of post-independence political developments in Pakistan and India. (Identical with POL 586)

590. * Women in Middle Eastern Society (3) I (Identical with ANTH 590)

592. * History of Sufism (3) II (Identical with HIST 592)

599. Colloquium
   a. Middle East (3) [Rpt.] I II
   b. * Ancient Near East (3) [Rpt.] I II Consult department before enrolling (Identical with JUS 599f)

596. Seminar
   a. Special Topics in Near Eastern Studies (3) [Rpt.]
   b. Middle East: Topics in History and Civilization (3) [Rpt.] I II
   c. Near Eastern Archaeology (3) [Rpt.] I II (Identical with ANTH 596c)
   d. * Feminist Approaches to the Bible (3) I (Identical with JUS 596w)

   *May be convened with 400-level course.

696. Seminar
   a. Cultural Anthropology (1-3) I (Identical with ANTH 696, which is home)
   b. International Water Resource Management (1-3) [Rpt.] I (Identical with HWR 696i, which is home)
Neuroscience (NRSC)
Gould-Simpson Building, Room 401
(602) 621-8380
Graduate Interdisciplinary Program in Neuroscience

Committee:

Professors John G. Hildebrand, Chairperson
(Arizona Research Laboratories, Division of Neurobiology), A. Terry Bahill (Systems and Industrial Engineering), Carol A. Barnes (Psychology), Bryant Benson (Anatomy), James R. Bloedel (Physiology), Richard Bootzin (Psychology), Thomas P. Davis (Pharmacology), Roger Enoka (Exercise and Sport Sciences, Physiology), Edward D. French (Pharmacology), Merrill F. Garrett (Psychology), Theodore Glattke (Speech and Hearing Sciences), Raphael P. Gruener (Physiology), Mac E. Hadley (Anatomy, Molecular and Cellular Biology), Thomas J. Hixon (Speech and Hearing Sciences), Victor J. Hruby (Chemistry), Sigmund Hsiao (Psychology), Mary I. Johnson (Pediatrics), Alfred W. Kasznia (Psychology), David L. Kreulen (Pharmacology, Physiology), Hugh E. Laird, II (Pharmacology and Toxicology), Robert Lansing (Psychology), Ronald J. Lukas (Pharmacology), Bruce L. McNaughton (Psychology), Lynn Nadel (Psychology), L. Claire Parsons (Nursing), Frank Porreca (Pharmacology), William R. Roeske (Internal Medicine), Alan B. Rubens (Neurology), Joachim F. Seeger (Radiology), Robert F. Spetzler (Surgery), Lawrence Z. Stern (Internal Medicine), Nicholas J. Strausfeld (Arizona Research Laboratories, Division of Neurobiology, Anatomy), Douglas G. Stuart (Physiology), Marc E. Tischler (Biochemistry), Henry Yamamura (Pharmacology)

Associate Professors Edmund A. Arbas (Arizona Research Laboratories, Division of Neurobiology), Kathryn A. Bayles (Speech and Hearing Sciences), Gail D. Burd (Anatomy, Molecular and Cellular Biology), William M. Feinberg (Neurology), Laurel A. Fisher (Pharmacology), Richard B. Levine (Arizona Research Laboratories, Division of Neurobiology, Physiology), Erwin B. Montgomery, Jr. (Neurology), Linda Swisher (Speech and Hearing Sciences), Leslie P. Tolbert (Arizona Research Laboratories, Division of Neurobiology), Gary L. Wenk (Psychology, Neurology)

Assistant Professors Geoffrey L. Ahearn (Neurology, Psychology), Ralph E. Frey (Exercise and Sport Sciences), Herman Gordon (Anatomy), Jeannette D. Hoit (Speech and Hearing Sciences), Josephine Lai (Pharmacology), Nathaniel T. McMullen (Anatomy, Neurology), David B. Morton (Arizona Research Laboratories, Division of Neurobiology), Naomi E. Rance (Pathology), John W. Regan (Pharmacology and Toxicology), Linda L. Restifo (Arizona Research Laboratories, Division of Neurobiology, Neurology), Paul A. St. John (Anatomy), Scott B. Selleck (Arizona Research Laboratories, Division of Neurobiology), Andrea Youl (Pharmacology, Physiology)

The graduate interdisciplinary Program in Neuroscience offers a graduate program leading to the Doctor of Philosophy degree with a major in neuroscience, as well as a graduate minor in neuroscience. A Master of Science degree is granted only in rare instances when students who have already passed the M.S. evaluation requirement are unable to continue in the doctoral program. The program comprises faculty members from several departments in the colleges of Arts and Sciences, Engineering and Mines, Medicine, Nursing, and Pharmacy, as well as the Arizona Research Laboratories. The members of the Program in Neuroscience are the principal faculty of the graduate program and thus may serve as major advisors for students majoring in neuroscience. In addition, the program fosters research and communication in interdisciplinary neuroscience throughout the University. Research interests of the faculty range from molecular mechanisms in synaptic transmission to human neurological disorders. Faculty groups focus upon cognitive neuroscience, developmental neurobiology, human speech and hearing, insect neurobiology, neuropeptides, neuropeharmacology, and motor control. Information about the research interests of the faculty may be obtained from the program office.

503.* Laboratory in Mammalian Systems Neurophysiology (3) I II (Identical with PSYC 503)

537. Gerontology: A Multidisciplinary Perspective (3) I II (Identical with PSYC 537)

543.* Insect Neurobiology (3) II (Identical with ENTO 543)

565. Neural Encoding, Memory and Computation in the Mammalian Brain (3) I II (Identical with PSYC 565)

566.* Principles of Mammalian Systems Neurophysiology (2) I II (Identical with PSYC 566)

582. Topics in Neural Development (2) II 1993-94 An in-depth development of the cellular and molecular basis of neural development. Students will read and discuss journal articles dealing with the development of neurons and their synaptic connections. P, consult program office before enrolling. (Identical with ANAT 582, MCB 582 and PSIO 582)

583. Topics in Neural Plasticity (2) II 1994-95 (Identical with MCB 583)

584. Cellular Neurobiology (2) II 1993-94 (Identical with ANAT 584)

585. Neural Mechanisms of Behavior (2) II 1994-95 Discussion of the neural mechanisms of behavior; the control of movement; and integrative mechanisms and plasticity. Examples from vertebrates and invertebrates. (Identical with PSIO 585)

586. Intracellular Messengers (2) I 1993-94 Intracellular messenger systems in the nervous system, description of salient features of each mechanism, and discussion of a particular system which uses that messenger. P, 588, or permission of instructor. (Identical with BIOC 586 and MCB 586)

587. Biology of Neurological Disease (3) II 1993-94 Emphasis on reading, discussing and presenting the primary literature pertaining to scientific investigation of neurological diseases, e.g., multiple sclerosis, stroke, epilepsy. For graduate and medical students. Contact program office before enrolling. (Identical with ANAT 588, BIOC 588, MCB 588, and PSIO 588)


595. Colloquium a.* Antennal Lobe (1) [Rpt./6 units] I II S b.* Developmental Neurobiology (1) [Rpt./6 units] I II S c.* Neurophysiology (1) [Rpt./6 units] I II S d.* Brain, Behavior and Computation (1) [Rpt./6 units] I II S e.* Neurobiology (1) [Rpt./6 units] I II S *May be convened with 400-level course

695. Colloquium e. Science, Society and Ethics (1) I (Identical with MCB 695e, which is home)

700. Methods in Neuroscience (3) I III (Rpt.) Research rotations in the laboratories of faculty members within the neuroscience program. Consult neuroscience program office before enrolling.

701. Communication in Neuroscience (2) II Preparation of an essay, and instruction in scientific writing. Open to majors only. P, consult neuroscience program office before enrolling.
Nuclear and Energy Engineering (NEE)

Engineering Building, Room 200
(602) 621-2551

Professors William L. Filipponi, Barry D. Ganapol, David L. Hitrick (Emeritus), Roy G. Post (Emeritus), Robert L. Seale, Morton E. Wacks, John G. Williams

Associate Professors Morris Farr, Acting Head, Rocco A. Fazzolari

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in nuclear engineering. These programs prepare the student for advanced study and research in various applications of nuclear energy including the analysis and design of fission and fusion reactors, the dynamics of nuclear systems, the interaction of radiation with matter, nuclear safety, energy systems analysis and management, nuclear fuel cycle evaluation, and the many specialized uses of isotopes. Master's degree students may select one of the following interdisciplinary options: biomedical engineering or energy systems engineering. For details concerning these options, see Engineering elsewhere in this catalog.

The applicant should have completed the equivalent of the undergraduate major in nuclear engineering, but liberal substitutions are allowed for those with undergraduate majors in mathematics, physics, chemistry, or other engineering disciplines.

For the Master of Science degree a thesis is required of all students except those working in the energy systems engineering option.


506.* Nuclear Engineering Laboratory (4) I II Experimental techniques for determining various parameters in nuclear systems; experiments using the critical and subcritical reactors. 3R, 3L. P, 380 or 588.

507. Radiochemistry and Radiation Detection (3) I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. 3R, 3L. P, CHEM 480b or PHYS 330. (Identical with CHEM 507)

514.* Energy System Design (3) II Modern engineering design methods to effectively use thermal energy and power. Covers: economic analysis and modeling of thermal equipment; optimization techniques; steady state and dynamic simulation of energy systems. Comprehensive project. CR, AME 432.

540.* Energy Utilization and Management (3) I Methods for evaluating the technical and economic aspects of energy conversion and usage directed toward the effective utilization of resources, including economics, HVAC systems, electric power, lighting and industrial processes.

541. Industrial Energy and Power Management (3) II Analysis of effective energy utilization in industrial operations; availability analysis, combustion, heat recovery, process energy, building systems, cogeneration, electrical loads, lighting and machinery. (Identical with CH E 541)

542.* HVAC System Design (3) II Analysis and design of air conditioning systems for commercial and industrial buildings, including equipment and component selection. Energy-efficient concepts, controls and computer analysis will be emphasized. P, 441. (Identical with AME 542).

543. Power Plant Engineering (3) II The application of fluid dynamic heat transfer and mechanical interaction principles to the engineering design of a power plant. P, 582, 588.

545.* Solar Energy Engineering (3) I Energy analyses of active and passive solar collectors; selective surfaces; solar cells; energy storage; systems for solar heating and cooling; mechanical and electrical power; perspective. P, AME 230.

546.* Photovoltaic Systems Engineering (3) I Presents system performance prediction methods, load estimation, power conditioners, battery storage principles, system design, and qualitative semiconductor device physics.

547.* Direct Energy Conversion (3) II Engineering requirements for achieving direct conversion of energy to electrical power; the engineering of thermoelectric and thermionic converters, fuel cells, magnetohydrodynamic, and photoelectric systems. P, MATH 254; AME 230; or PHYS 121. (Identical with AME 547 and ECE 547)

556.* Engineering System Simulation (3) II Dynamic modeling and simulation of engineering systems, including energy conversion systems, nuclear and chemical reactors, and control systems, using digital continuous-system simulation languages. P, AME 230 or CH E 306a; MATH 254.

563. Energy from Biomass (3) II (Identical with ABE 563)


582.* Contemporary Nuclear Power Systems (3) I Analysis of present nuclear power plants, with emphasis on design decisions as they affect performance of individual systems; advanced design concepts; proposed standard designs; comparison of different contemporary systems. P, 381 or 486.


584.* Radiation Effects (3) II Radiation effects on solids and radiation chemistry of gases and liquids, with emphasis on effects encountered in nuclear reactor, detector, and dosimeter systems. P, 380, CR, MSE 331R.

585.* Radiation Health Physics and Safety (3) I Study of health physics practices and safety responsibilities; analysis of radiation environments and applications of basic shielding methods to provide understanding of accepted working practices.

586.* Nuclear Energy and Power (3) I Fundamentals of nuclear energy and radiation; engineering applications; the basic concepts of nuclear reactors and power systems. Designed for nonmajors.

587.* Introduction to Radioactive Waste Management (3) I Background in the technology of the management of all types of radioactive wastes from the nuclear fuel cycle, institutions, and industry.


596. Seminar

s. Advanced Nuclear Power Activities (1) [Rpt.] III

*May be conformed with 400-level course.

645. Advanced Solar Engineering (3) II Research and development studies related to solar applications: engineering design, analysis, and economics. Course includes invited lectures, literature research, and an original paper. P, 545. (Identical with CH E 645)


681a-681b. Analytical Methods of Transport Theory (3-3) 1994-95 Application of the Boltzmann equation to neutron and photon transport problems; exact solutions, the method of singular eigenfunctions, spherical harmonic expansions, the moments methods, integral transport theory, invariant embedding, variational techniques, applications to slowing-down problems. P, 689, MATH 422a-422b.

682. Nuclear Safety (3) II Possible incidents involving nuclear materials in critical reactors, chemical processing systems, fuel shipment operations or subcritical arrays, including assessments of the magnitudes and consequences of nuclear incidents; determination of criteria for evaluating nuclear system safety, including plant siting and operational procedures. P, 380.

683. Nonlinear Reactor Dynamics (3) II Non-linear dynamics of nuclear reactors; shutdown mechanisms, inertial effects, nonlinear stability criteria, time-dependent neutron transport, neutron waves, and applications to...
The College of Nursing of the University of Arizona offers a graduate program leading to the Master of Science degree in Nursing. The program is designed to prepare individuals for advanced practice in nursing roles such as clinical nurse specialist, nurse practitioner, and nurse researcher. Admission to the program is based on a combination of academic preparation, professional experience, and demonstrated potential for advanced study. Applications are reviewed in the fall, and decisions are made on an individual basis. For more information, contact the College of Nursing, Room 316, Nursing Building, University of Arizona, Tucson, AZ 85721; (602) 621-6151.

The College of Nursing offers a variety of courses designed to meet the needs of students pursuing advanced degrees in nursing. These courses cover a wide range of topics, including statistics, research methods, and clinical nursing. The courses are offered both in traditional classroom settings and through distance learning options. Students are encouraged to explore the diverse offerings available to them and to identify those courses that best fit their academic and career goals.

Applicants for all degree programs are required to submit (1) evidence of completion of an undergraduate program in nursing substantially equivalent to the Bachelor of Science in Nursing degree program at the University of Arizona, (2) a current license to practice as a registered nurse in Arizona, (3) references attesting to professional competence, (4) evidence of satisfactory completion of a course in elementary statistics, (5) scores on the aptitude test of the Graduate Record Examination, (6) a statement indicating academic and professional goals as well as research interests, and (7) evidence of skills in physical assessment. In addition, (8) computer literacy is required.

An automobile is essential since the clinical facilities are located throughout the Tucson area.

Degrees

The College of Nursing offers a graduate program with multiple exit options: (1) Students may elect to complete a one-year M.S. program including a thesis, or (2) elect to use the master’s level courses as the first year of the Ph.D. program. In this option, a research proposal, rather than a thesis, is required and the M.S. degree is not awarded.

Clinical nursing areas offered are child, community health, geriatric, maternal-newborn, medical-surgical, and psychiatric-mental health. Role development areas are nursing education, nursing administration, geriatric nurse practitioner, and mental health clinical specialist.

Master of Science—Admission is based upon the evaluation of the criteria mentioned above as well as the following: undergraduate cumulative grade point average of at least 3.00 or “B”; Graduate Record Examination minimum score of 500 each on the verbal and quantitative portions of the aptitude test; and references attesting to potential as a graduate student.

Doctor of Philosophy—The major purpose of the program is the preparation of the clinical nurse researcher. Applicants must present evidence of the completion of a baccalaureate degree or both baccalaureate and master’s degrees substantially equivalent to those nursing programs at the University of Arizona. Admission is based upon the evaluation of the following criteria: undergraduate cumulative grade point average at least 3.00 or “B”; Graduate Record Examination minimum scores of 550 each on the verbal, quantitative, and analytical portions of the aptitude test; and references attesting to potential as a doctoral student; copies of published materials or research reports; and an evaluation of professional record and experience. A personal interview is required after all credentials are available.

A minor area of study which includes a minimum of 12 semester credits is required. The area of study may be selected from behavioral or biological sciences, or the disciplines of anthropology, philosophy, physiology, psychology, management and policy, sociology or statistics.

Upon completion of the M.S. or Ph.D. degree, a student will have met the following objectives: devise, negotiate, implement and evaluate alternative solutions for health problems affecting client populations; expand and communicate the body of nursing knowledge; and generate solutions for society’s health concerns through collaboration with the broader scientific and health communities.

504. Conceptual Models (3) S Theory and research surrounding conceptual models with emphasis on description of conceptual models.

521.* Nursing Care of the Child with a Handicap or Chronic Illness (3) S Overview of congenital and acquired handicaps or chronic conditions in school age children. Assessment and management in the school setting of these children and their families. Open to majors only. P. 481, or consult college before enrolling.

522.* School Nursing Practice (3) I Analysis and application of nursing in school systems. Program development and evaluation, health curriculum development, and principles of epidemiology for identification of high risk groups. Open to majors only. P. 481, or consult college before enrolling.

530. Methods in Nursing Research (3) I Critical examination of selected problems and methods in the nursing research process. Consideration is given to both qualitative and quantitative methods.

548. Statistical Packages in Research (3) I Analysis of data for research projects, theses and dissertations using SPSS and SAS. Organization of data for statistical analysis, entering data and creating command files using the editor, writing and debugging programs. Techniques for producing graphical output using SAS/GRAPH. P. one introductory graduate-level course in statistics. (Identical with STAT 548)

580.* Principles of Physiology in Health Care (4) S Selected physiologic functions and adaptive changes which occur in health and illness. Cellular physiology, the immune system, neurophysiology, cardiovascular, pulmonary, renal, and endocrine physiology. P. undergraduate physiology.

583.* Perspectives of Cancer Care for Health Professionals (3) S Current methods of care for individuals with cancer and for their families. 6R, 9L. Not accepted in doctoral program of study in nursing. P. enrollment in
baccalaureate or graduate programs in nursing or pharmacy. (Identical with PHPR 583)

587. *Poverty and Health (3) II Study of the relationship between poverty and health. Concepts and theories from anthropology, psychology and sociology will be used to analyze problems associated with poverty. Advanced degree credit available for non-Ph.D. majors only. P, six units of social science. (Identical with ANTH 587 and FCM 587)

588. Clinical Anthropology (3) I II Application of principles from anthropological theory to the actual practice of patient care, with emphasis on culturally appropriate interventions. Students will earn 600 units of advanced degree at the greater Southwest. P, nine units of behavioral science. (Identical with ANTH 588 and FCM 588)

589. Health of the Older Adult (3) I Current research of the aging process including physical and mental alterations; emphasis on physiological changes. Consult college before enrolling. (Identical with GERO 589)

*May be convened with 400-level course.

600a-600b. Nursing Theory and Practice (3-3) I II Maintenance, therapeutic and preventive nursing care of persons in various settings. Student elects practice in one area of nursing: 600a (I) is selected for (1) child, (2) maternal-newborn, or (3) psychiatric-mental health. 600b (II) is chosen for (1) community health, (2) gerontology, (3) medical-surgical.

601. Pathophysiological Alterations (3) I Alterations in physiologic mechanisms secondary to alterations in perfusion, oxygenation, hydration, osmolality, temperature, and resistance to infection. P, 580 or 3 hours of graduate-level physiology.

602. Public Health Science (3) I Health promotion and primary prevention in communities and populations, epidemiology and legal/political issues in advanced public health nursing. Nursing and public health theories synthesized. Open to majors only.

603. Developmental Concepts in Nursing (3) I II Examination of concepts of development over the life span and their relationship to nursing phenomena. Different models or views of development are explored and applied to nursing theory development, research, and practice. Open to majors only.

604. Issues in Family Relations (3) I II Examination of issues in providing care to families using theory and research from nursing and related fields. Concepts included will apply to the young, developing, and mature family. Open to majors only.

605. Social, Psychological Problems in Nursing (3) I II Focus on concepts of stress and training with emphasis on health-related outcomes. Nursing research on addictions, depression, abuse and violence will be explored. Open to majors only.

606. Cross-Cultural Nursing (3) S Focus on a synthesis of theories from nursing and related fields to explore cultural variations in response to actual or potential problems of health or illness. The methods for caring and treating culturally influenced responses will be examined. Open to majors only.

607. Cognitive Alterations (3) S Client problems related to the processing of sensory information including etiological factors. Research-based nursing interventions for clients with cognitive alterations are examined. Open to majors only.

608. Health Assessment (3) I Focus on synthesis of physical and psychosocial data by using current research and theoretical models in geriatric nursing. Emphasizes physiology, physical, cultural and psychosocial assessment. Open to majors only. P, 580.

609. Educational Process (3) I Theoretical and practical application of teaching-learning processes in classroom and clinical settings. Principles of teaching, learning, instructional design, testing, Microteaching included. 2R, 3L. Open to majors only.

610. Cultural Anthropology (3) I II Application of theory and research from nursing and related fields to explore cultural variations in health or illness. The methods for caring and training with emphasis on health-related outcomes in the greater Southwest. P, nine units of behavioral science. (Identical with ANTH 588 and FCM 588)

611. Clinical Agency Administration (3) I II Practical application of administrative processes in a nursing care delivery setting. Focuses on the use of selected skills essential to effective administration. Open to majors only. P, 624.

612. The Administrative Process (3) I Theoretical background for nursing administration in care settings. Emphasizes on accountability, budgeting, management skills, constraints and influences as related to nursing administration. Open to majors only.

613. Geriatric Nurse Practitioner Role (3) I Exploration of models of advanced nursing practice role in health care system. Emphasizes factors that influence process of defining and implementing geriatric nurse practitioner role. Open to majors only. P, 580.

614. The Practice Setting (3) I II Focuses on concepts and skills needed to manage therapeutically the common acute and chronic health problems prevalent in older adults. Emphasizes clinical decision-making in abnormal aging. Open to majors only. P, 625.

615. Mental Health Nursing Clinical Therapeutic Process (3) I Focus on concepts of personality development using psychodynamic and cognitive-behavioral theories oriented to the practice of mental health nursing: employing individual, family and group nursing techniques for the amelioration of problems. P, 600a, graduate standing in nursing.

616. Mental Health Nursing Advanced Clinical Practice (3) I Focus on the application of cognitive and behavioral theory in the mental health clinical setting, emphasizing individual and group modalities. Open to majors only.

617. Research Utilization (3) S Development and use of models and tools for facilitating the use of research in science-based nursing practice within organizational settings. 2R, 3L. P, 530.

620. Evaluation Research (3) I Development and use of models and tools for assessing nursing processes, programs and performances. Approaches to and psychological reactants of evaluation are explored. Issues and development of market packages with cost consideration are discussed along with program grant preparation.

621. Issues in Rural Health Care (3) II Topics include community assessment, planning and evaluation; interdisciplinary practice; health care issues for southwestern ethnic minority populations. (Identical with MAP 635, PHPR 635, and PSYC 635)

705. Nursing Metatheory (3) I Logical testing of theories in practice; history of nursing theory development related to basic epistemology, history, and philosophy of science; alternate meta-theoretical structures, clinical theory development strategies; provision for an exercise in theory construction. Laboratory is required. P, 6 units of clinical specialty or clinical selective. 3 units of advanced human physiology, 3 units of social science at an advanced level.

710. Clinical Practice (3) I II Introduction to ways of knowing, focus on middle range theories in nursing and related sciences. Emphasis on critique, elaboration and theory testing strategies. Open to majors only. P, 705.

724a-724b. Professional Role Development (1-1-1) I II Assist student socialization into the role of nurse scientist. Ethics of research, development of grant proposals, dissemination of scholarly work through publication and presentation, balancing roles of scholar, educator and clinician. Open to majors only. P, admission to Ph.D. program.

725. Study of Social Infl uences (3) I In-depth examination of social forces affecting the health care system. Open to majors only. P, admission to Ph.D. program.

730. Quantitative Methods in Clinical Nursing Research (3) I Investigation of selected quantitative strategies appropriate to researching problems in clinical nursing. Open to majors only. P, 530, 633, admission to Ph.D. program.

731. Qualitative Methods in Clinical Nursing Research (3) I Application of selected qualitative research methods from the social sciences to clinical nursing. Open to majors only. P, 530, admission to Ph.D. program.

781a-781b. Instrument Construction (3-3) S Deductive and inductive processes for constructing/testing instruments to measure nursing care interventions/patient outcomes. 781a: Instrumentation for behavior and objective phenomena. 781b: Instrumentation for subjective phenomena. Includes instrument strategies; experience developing a pilot measure. 2R, 3L. Open to majors and minors only. P, 705, 730, graduate level statistics. 781a is not prerequisite to 781b. (781a and 781b offered alternate summers.)

782a-782b. Field Work in Nursing Research (3-3-3) S I II Individualized course of study incorporating research and clinical knowledge in a selected area of nursing practice in the laboratory and field setting. P, 530, 600a-600b, 633, 705, 730.
Nutrition and Food Science (NFS)

Shantz Building, Room 309
(602) 621-1187

Professors Bobby L. Reid, Head, James W. Berry (Emeritus), Patsy M. Brannon, Archie J. Deutschman, Jr. (Emeritus), Mary Ann Kight, K.Y. Lei, John A. Marchello, William F. McCaughley (Emeritus), Donald J. McNamara, Eugene Nelson (Emeritus), Franklin D. Rollins (Emeritus), Mitchell G. Vavich (Emeritus), Charles W. Weber

Associate Professors Douglas L. Park, Ralph L. Price, Edward T. Sheehan, Ann M. Tinsley

Assistant Professor Wanda H. Howell

The department offers programs leading to the Master of Science degree in food science, nutritional sciences, and dietetics. Graduate study prepares students for careers in academia, health care, industry and government. The department also participates through the Committee on Nutritional Sciences in programs leading to the Doctor of Philosophy in nutritional sciences. (See Nutritional Sciences in the following section.)

Prerequisites for admission include: for the M.S. in food science: one semester each of analytical chemistry with lab and microbiology with lab, one year (or its equivalent) each of physics, general biology, organic chemistry with lab and math (calculus recommended); for the M.S. in nutritional sciences: one semester of analytical chemistry with lab, one year each (or its equivalent) of physics, organic chemistry with lab, biochemistry and physiology, and math (calculus recommended); for the M.S. in dietetics: completion of an ADA-approved Plan IV undergraduate program.

Graduate students must complete at least 30 units including an approved thesis to receive the M.S. in food science, nutritional sciences, or dietetics. Students are encouraged to select an advisor and two additional faculty members for their graduate committee as soon as possible, but no later than their second semester. The program of study must include N FS 520 or N FS 540 or N FS 558; 2 units of N FS seminar; 6 units of thesis; 6 units of N FS 50-600 level electives; 3 units of statistics; 4 or more units of biochemistry.

520. Advanced Nutritional Science (3) I Advanced physiology and biochemistry of nutrients with emphasis on present knowledge and current research topics in nutritional sciences. P. BIOC 460 or 462a.

540. Advanced Dietetics (3) I Nutrition and metabolism in patient care as applied by the advanced-level practitioner. Open to majors in nutritional sciences only.

541. Therapeutic Nutrition (4) II Therapeutic principles of nutrient acquisition and utilization, including modification of the diet, for selected disease and/or deficiency states; factors of importance in client/patient care, rehabilitation and education. P. 408.

547. Perspectives in Geriatrics Laboratory (1) I (Identical with PHFR 547)

558. Advanced Food Science (3) I Food safety evaluation, microbiology of pathogens and beneficial organisms, chemistry, engineering, processing; analytical chemistry; laws, regulations. P. CHEM 241a-241b, 322; PHYS 102a-102b; MATH 117B/S.

559. Sensory Evaluation of Food (3) I 1993-94 Fundamentals of taste, odor, color, flavor and rheology perception as related to food; design and methodology of small-panel and consumer-panel testing. 2R, 3L.

563. Food Analysis (3) II 1993-94 Laboratory procedures for chemical and physiochemical analysis of food products. 1R, 6L. P. 360.

568. Nucleic Acids (4) I (Identical with BIOC 568)

570.* Food Microbiology and Sanitation (3) I 1994-95 Microbiology in processing and handling of foods; relation of microorganisms, insects, and rodents to design and function of processing and handling equipment.

571.* Food Microbiology and Sanitation Laboratory (2) II 1994-95 Laboratory procedures for assessment of sanitary quality of foods. P. 470 or CR.

572. Food Laws, Standards, and Regulations (2) II 1994-95 Laws, standards, and regulations governing food marketing in the United States; emphasis on food safety, inspection procedures, additives, nutritional labeling and regulatory agencies. P. 6 units from the following: 468, 470; MKTG 470.

596. Seminar n. International Nutrition (2-3) II (Identical with FCM 596n, which is home)

561. Bioenergetics (2) I 1993-94 (Identical with AN S 601)

602. Metabolic Integration (3) I Food intake, transport, protein and amino acid utilization in higher animals. P. 408.

609. Nutritional Biochemistry Techniques (3) II Biochemical methods for evaluating metabolic functions of nutrients. 1R, 6L. P. 408, CHEM 324 or 325, and 323 or 326. (Identical with AN S 609)

615. Chemistry and Metabolism of Lipids (3) I 1993-94 Chemistry and structure of lipids and their digestion, adsorption, transport and utilization; current research in lipid metabolism and the role of lipids in certain disease states. (Identical with AN S 615)


622. Mineral Metabolism (2) I 1993-94 Chemistry, metabolism and biological function of minerals; current research in mineral requirements and toxicity. P. 408. (Identical with AN S 622)

628. Steroid and Lipoprotein Chemistry and Metabolism (2) I 1993-94 Chemistry and metabolism of mammalian sterols and lipoproteins; biosynthesis and metabolism of sterols and lipoproteins in health and disease; the role of diet in treating abnormalities of sterol and lipoprotein metabolism; sterols and disease. P. 408.

630. Developmental Nutrition (3) I 1994-95 Role of nutrients in development, growth and lactation; changes in maternal and infant nutritional requirements; current research in developmental nutrition. P. 520, MCB 511 or BIOC 572 recommended.

640. Field Methods in Human Nutrition (3) II 1993-94 Case-oriented approach to nutritional assessment, diagnosis, prescription, plan and program application of dietary, clinical and biochemical methods. 2R, 3L. Open to majors in nutrition and other health sciences areas only.

663. Chemistry of Food Carbohydrates (2) I 1994-95 Chemical and physical properties of carbohydrates important to their presence in food. P. BIOC 460, 462a.

665. Analysis and Purification of Proteins (3) I 1993-94 (Identical with AN S 665)

672. Food Safety (2) I 1993-94 Significance and control of foodborne hazards associated with pathogenic microorganisms, microbial toxins, industrial chemicals, and other environmental contaminants. P. 471, CHEM 241b. (Identical with MBIM 672)

693. Internship
   a. Dietetic Internship, ADA Accredited (1-6) [Rpt./2] I II Field trips. Begins Mid-August and continues for 46 weeks. Consult dept. before enrolling. Open to majors only. P. Course work equivalent to American Dietetic Association Plan IV.

696. Seminar
   b. Nutrition (1) [Rpt./6 units] I II (Identical with NUSC 696b)

Nutritional Sciences (NUSC)

Shantz Building, Room 309
(602) 621-5630

Graduate Interdisciplinary Program in Nutritional Sciences

Committee:

Professors Bobby L. Reid, Chair (Nutrition and Food Science), David S. Alberts (Internal Medicine), Ronald E. Allen (Animal Sciences), Harris Bernstein (Microbiology and Immunology), Patsy M. Brannon (Nutrition and Food Science), Milos Chvapil (Surgery), David L. Earnest (Internal Medicine), Charles Gerba (Soil and Water Science), J. Tal Huber (Animal
Nutritional Sciences—Optical Sciences

The interdepartmental Program on Nutritional Sciences offers graduate work leading to the Doctor of Philosophy degree with a major in nutritional sciences. Options in nutritional biochemistry, food safety, human nutrition (clinical or community), or animal nutrition may be selected within this major. The Program on Nutritional Sciences represents a group of faculty members located in various departments of the University, who participate in graduate training in all areas of nutrition. Only faculty who are members of this larger group, called the Graduate Group in Nutritional Sciences, may serve as major advisers for students majoring in nutritional sciences. Research direction is available in all areas of nutrition, including nutritional biochemistry, human nutrition, clinical and community nutrition, and animal nutrition.

Undergraduate preparation must include a semester each of algebra and calculus or trigonometry (calculus is recommended) and one year each of general biology, physics, and organic chemistry with laboratory. A semester of quantitative analysis is required for students selecting the options in nutritional biochemistry or animal nutrition. GRE scores for quantitative and verbal tests are requested for admission.

Degree

Doctor of Philosophy: The student's course of study will be developed by the student and the major advisor and approved by the student's graduate advisory committee and the Program in Nutritional Sciences. Students must meet the minimum requirements established for the master's degree in their options, plus additional requirements specified by the student's graduate advisory committee, before obtaining the Ph.D. A maximum of ten units of individual studies (599, 699, 900) and seminar (596, 696) credits will be counted toward requirements for the degree.

A minor may be chosen from a variety of areas including biochemistry, animal physiology, physiology, molecular and cellular biology, ecology and evolutionary biology, food science, anthropology, pharmacology, and chemistry.

605. Methods in Nutritional Research (3) I Survey of experimental approaches to nutrition research in the areas of food safety, animal nutrition, nutritional biochemistry and human nutrition.

696. Seminar

b. Nutrition (1) I II (Identical with NFS 696b, which is home)

Optical Sciences (OPT)

Optical Sciences Center, Room 401
(602) 621-4111

Graduate Interdisciplinary Program in Optical Sciences

Committee:

Professors Richard C. Powell, Chair, J. Roger P. Angel (Steward Observatory), George H. Atkinson (Chemistry), Harrison H. Barrett (Radiology), Peter H. Bartels (Pathology), James J. Burke, William J. Dallas (Radiology), Eustace L. Dereniak, Charles M. Falco (Physics), Peter A. Franken (Physics), B. Roy Frieden, Kenneth F. Galloway (Electrical and Computer Engineering), Jack D. Gaskill (Electrical and Computer Engineering), Hyatt M. Gibbs, Bobby R. Hunt (Electrical and Computer Engineering), Kenneth A. Jackson (Material Science and Engineering), Stephen F. Jacobs, Stephen W. Koch (Physics), George L. Lamb, Jr. (Mathematics), Willis E. Lamb, Jr. (Physics), H. Angus MacLeod (Electrical and Computer Engineering), Masud Mansuripur, Arvind S. Marathay, Aden M. Meinel (Emeritus), Pierre Meystre, Dennis D. Patton (Radiology), Nasser Peyghambarian, John A. Reagan (Electrical and Computer Engineering), Ralph M. Richard (Emeritus), Murray Sargent III, Dror Sarid, Bernard O. Sathorn (Emeritus), Roland V. Shack, Robert R. Shannon (Emeritus), Richard L. Shoemaker, Philip N. Slater (Remote Sensing), Orestes N. Stavroudis (Emeritus), A. Francis Turner (Emeritus), Donald R. Uhlmann (Materials Science), William H. Wing (Physics), William L. Wolke, Jr. (Radiology), James C. Wyatt (Electrical and Computer Engineering)


The Program in Optical Sciences offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in optical sciences. Areas in which research is currently being conducted include electro-optics, image formation, image processing, laser physics, materials, medical optics, non-linear optics, optical bistability, optical design, optical fabrication and testing, optical properties of materials, pattern recognition, quantum optics, remote-sensing, spectroscopy, surface physics, and technology. Interdisciplinary programs in progress involve the departments of Astronomy, Chemistry, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Physics, and Radiology, as well as the Arizona Research Laboratory, the Optical Circuitry Cooperative and the Data Optical Storage Center.

Applicants should hold a bachelor's degree in engineering, mathematics, or physics. In addition to the application materials submitted to the Graduate College, applicants must submit to the Associate Director, Academic Affairs, Optical Sciences Center, University of Arizona, Tucson, Arizona 85721, the following materials: one complete set of transcripts, scores on the aptitude and subject (engineering, mathematics, or physics) tests of the Graduate Record Examination, and at least two letters of recommendation. Normally, students are only admitted to begin their studies in
Optical sciences during fall semester. The deadline for submission of all application materials is March 1; however, because of the large number of applications received each year, early submission is encouraged to enhance the chances of admission.

Degrees

Master of Science: There is no core curriculum for the Master of Science degree, and students are allowed considerable freedom in planning their study programs. Students may elect either of two options:

Thesis option: A minimum of 32 units of graduate credit in optics or optics-related courses, including 8 units of 910 (thesis) and at least 2 units of optics laboratory courses, and a final oral examination based primarily on the thesis.

Non-thesis option: a minimum of 35 units of graduate credit in optics or optics-related courses, including at least 2 units of optics laboratory courses; demonstrated competence in written communication (either by writing an acceptable Master's Report or successfully completing an appropriate course in technical writing); a final oral examination, based primarily on the subject matter of the courses taken.

In addition, the Master of Science degree may be awarded to prospective candidates for the Doctor of Philosophy degree upon successful completion of the preliminary examination.

Doctor of Philosophy: A core curriculum, including courses 501, 502, 503, 504, 505, 506, 507, 508, and 509 has been developed to help doctoral students prepare for the preliminary examination. These courses are not required, but students are expected to know the material presented in them. There is no foreign language requirement for the Doctor of Philosophy major in optical sciences. Students must include at least two units of optical laboratory courses or provide evidence of equivalent laboratory experience. At the discretion of the committee, doctoral students with majors in optical sciences, as well as those majoring in other disciplines, may elect a minor in optical sciences. Such students must complete, for the minor, twelve units of course work with a grade of "B" or better in optical sciences or obtain approval for the equivalent in transferred course work. No more than six of these units may be crosslisted with the student's major department (if other than optical sciences).


502. Optical Engineering I (3) I Rays and wavefronts; Fermat's principle; Snell's law; dispersion; systems of plane mirrors; Gaussian and paraxial imagery; Delano diagram; radiometry; blackbody radiation, sources. P, PHYS 116, 121.

503. Quantum Optics and Lasers (3) I Quantum background; interaction of light with matter; two-level atom; lasers; nonlinear optics. P, PHYS 435 (Identical with PHYS 503)

504. Mathematical Methods for Optics (3) I Complex variables; Fourier theory and applications to imaging; coherent and incoherent imaging; other integral transforms; special functions and orthogonal polynomials; linear algebra; integral equations; Green's functions. P, MATH 223, PHYS 116 or PHYS 121.


507. Solid-State Optics (3) I Basic concepts in crystals and in optical response; optical properties of phonons and semiconductors; quantum wells; electro-optical properties of bulk semiconductors; optical nonlinearities; solid state devices and laser diodes. P, PHYS 435.

508. Probability and Statistics in Optics (3) II Probability theory; random processes; optical applications; hypothesis testing and estimation; physical applications. P, 509 or 511; 512 or 504.

509. Fundamentals of Physical Optics (4) II Electromagnetic theory; interference; concepts of coherence; multiple-beam interference and multilayer films; general, Fresnel, and Fraunhofer diffraction; diffraction gratings; Gaussian beams; holography; speckle. P, PHYS 116.

509L. Fundamentals of Physical Optics Laboratory (I) I Laboratory in support of 509. P, 501 or 509.

510. Fundamentals of Applied Optics (4) II Optical systems; Gaussian optics; aberrations; radiometry; sources; detectors; optical engineering. P, PHYS 116, 121.

510L. Fundamentals of Applied Optics Laboratory (I) I First-order design; assembly and alignment; camera lens layout and construction; lens properties; aberrations; CCD-TV camera; radiometry; illumination; distortion; MTF. P, 506 or 510.

511. Lasers and Solid-State Devices (4) I 1993-94 Microscopic theory of light-matter interactions; laser and other light sources; solid-state optics; semiconductor diodes, lasers, detectors; nonlinear optics. P, 501 or 509; 504 or 512.

511L. Lasers and Solid-State Devices Laboratory (I) I Gas and semiconductor lasers; modes and beats; modelocking; spectrum analysis; exitons and quantum wells; noise; modulators and detectors; second-harmonic generation; coherent optical transients. P, 511 or 503, 507.

512. Fourier and Statistical Optics (4) I Mathematical background; convolution; the Fourier transform; linear filtering; two-dimensional operations; diffraction; image formation; probability and random variables; stochastic processes; random data. P, MATH 223, PHYS 116 or PHYS 121.

512L. Mathematical Optics Laboratory (I) I Laboratory in support of 504, 508 and 512. P, 504 or 512 and C 5C 227 or SIE 270.


514. Aberration Theory (3) I 1992-93 Aberration theory; geometrical image formation; diffraction; pupil, spread, and transfer functions; random wavefront perturbations; system effects; image evaluation; image processing. P, 506.

517. Lens Design (4) I Fundamentals of optical system layout and design: exact and paraxial ray tracing; aberration theory; chromatic and monochromatic aberrations. 2R, 6L. P, 506.

524. Optical Data Processing (3) II 1991-92 Inverse filtering; matched filtering; frequency-domain synthesis; the Vander Lugt filter; shadow-casting correlators; OTF synthesis; coded-aperture imaging. P, 505.

527. Holography (3) II 1992-93 Historical background; the Gabor hologram; the hologram as a zone plate; Fresnel, image, Fourier-transform, and reflection holograms; practical holography; limitations. P, 505. (Identical with ECE 527)


531. Image Processing Laboratory for Remote Sensing (3) I (Identical with ECE 531)

532. Computer Vision (3) II (Identical with ECE 532)

533. Digital Image Processing (3) II 1991-92 (Identical with ECE 533)

534. Advanced Topics in Electronic Materials (3) [Rpt./2] 1994-95 (Identical with MSE 534)


539. Estimation Methods in Optics (3) I 1991-92 Bayesian MAP and MMSE estimation, maximum entropy estimates, restoration of
images and spectra, phase retrieval, medical images, significance tests. P, 502.
540a-540b. Atomic and Molecular Spectroscopy for Experimentalists (3-3) (Identical with PHYS 540a-540b)

541. Introduction to Lasers (3) II Laser theory; properties of lasers; stimulated emission; dispersion theory; gain saturation and rate equation; optical resonators; survey of laser types and mechanisms. P, PHYS 103b.

541L. Introduction to Lasers Laboratory (1) II Laboratory in support of 541. P, CR, 541.

543. Laser Physics (3) I Density matrix formulation of interaction of radiation with matter; semiclassical laser theory; single and multimode scalar fields; moving atoms; ring and Zeman lasers; pressure effects. P, 504. (Identical with PHYS 543)

544. Advanced Linear Optics (3) I 1991-92 Normal modes of matter; macroscopic electrodynamics; optical activity; crystal optics; electro-optics; magneto-optics; bulk acousto-optics; scattering, P, 501.

545. Nonlinear Optics (3) II 1991-92 Scattering of light; parametric amplification; Brillouin, Raman, Rayleigh scattering; stimulated and spontaneous interactions; frequency multiplication; intense field effects; materials damage theory. P, 501.

550. Fundamentals of Remote Sensing (3) I Physics and methodology of remote sensing; radiometry; data collection systems; photointerpretation; photogrammetry; image enhancement and classification; applications in the earth sciences.

558. Radiometry (3) I 1991-92 Units and nomenclature; Planck's law; black bodies; gray bodies; spectral emitters; Kirchoff's law; flux concepts; axial and off-axis irradiance; radiative transfer; normalization; coherent illumination; radiometric instruments. P, 501.

559. Infrared Techniques (3) I 1992-93 The radiant environment; atmospheric properties; optical materials and systems; detector description and use; data processing; displays; systems design and analysis. P, 558.

561. Physics of the Solid State (3) II (Identical with PHYS 561)

563. Photoelectric Imaging Devices (3) II Intensifiers; camera tubes storage tubes; specifications; evaluation; applications; electronic optics, human visual process, photon detection. P, PHYS 116.

566. Optical Detectors (3) II 1992-93 Photodetectors; semiconductors; signal and noise mechanisms; figures of merit; limitations on the sensitivity of detectors; photomultipliers; detectors of ionizing radiation. P, 507.

568. Solid-State Imaging Devices (2) I 1992-93 Charge transfer devices; monolithic and hybrid focal planes, figures of merit; time-delay integration; fat zero; transfer efficiency; double-correlated sampling; buried-channel and surface-channel devices. P, 507.

570. Advanced Optics Laboratory (2) II Hands-on experience in current optics research areas. Emphasis is device-oriented. Guided waves; acousto-optics; optical bistability; diode lasers; nonlinear optics; optical phase conjugation. 1R, 3L, P, PHYS 121.


577. Optics of Thin Films (3) II Dielectric interference films; semiconductor and metallic films; planar waveguide films; design methods for multilayer interference filter coatings; thin film components for integrated optical circuits. P, 508.

587. Fiber Optics Laboratory (3) II Fiber characteristics; fiber preparation; single and multimode fibers; sources, coupling; communication systems; multiplexing techniques; fiber-optic sensors. P, ECE 456. (Identical with ECE 587)

590. Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

595. Colloquium
a. Current Subjects in Optical Sciences (1) I II

596. Seminar

597. Workshop
a. Optical Shop Practices (3) I II 1R, 6L. P, 513, 513L.

*May be convened with 400-level course.

637. Principles of Image Sciences (3) II Mathematical description of imaging systems and noise; introduction to inverse problems; introduction to statistical decision theory; prior information; image reconstruction and radon transform; image quality; applications in medical imaging; other imaging systems. P, 504 or 512, 508.

643. Quantum Optics (3) II 1992-93 Quantum theory of electromagnetic radiation; spontaneous emission;Dicke superradiance; optical coherence and noise; quantum theory of the laser; superconductivity and Josephson radiation. P, 543. (Identical with PHYS 543)

656a-656b. Advanced Optics Laboratory (3) I 1992-93 (Identical with ATMO 656a-656b)

670. Principles of Optical Data Storage (3) II 1991-92 Optics of polarized light in systems of high numerical aperture; automatic focusing and tracking schemes; interaction of light and magnetic media; readout enhancement through multilayering; physical mechanisms of optical recording in ablative, phase-change, thermomagnetic and dye-polymer media; sources of noise in optical recording; data encoding schemes. P, consent of instructor.

680. Microcomputer Interfacing in the Optics Laboratory (3) I Design and construction of interfaces between microcomputer systems and a variety of devices in the optics laboratory, including switches, motors, optical sensors, displays and terminals. Hardware and assembly language software drivers. 1R, 6L.

696. Seminar
a. Advanced Optical Design (1-3) II P, 517.

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**Pharmaceutical Sciences (PHSC)**

Pharmacy Building, Room 236
(602) 626-2823


Associate Professors Joseph J. Hoffmann (Arid Lands Resource Sciences), Neil E. MacKenzie (Biochemistry), Barbara N. Timmermann (Arid Lands Resource Sciences)

Assistant Professor Sherry (Hsiao-Hui) Chow

The Department of Pharmaceutical Sciences includes the academic disciplines of pharmaceutical chemistry, biopharmaceutics/pharmacokinetics, pharmaceutics, and pharmacognosy. It offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in pharmaceutical sciences. Concentrations within the major include pharmaceutical chemistry, biopharmaceutics/pharmacokinetics, pharmaceutics and pharmacognosy.

A bachelor's degree in pharmacy, chemistry, or biological science is a prerequisite to admission to the graduate program. Admission to the doctoral program usually requires, in addition, appropriate preparation in mathematics. Three letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Correspondence for the areas of pharmaceutical chemistry and pharmacognosy should be directed to Dr. Arnold Martin. Correspondence for the areas of biopharmaceutics/pharmacokinetics and pharmaceutics should be directed to Dr. JoLaine Draugalis.

Teaching is part of the graduate learning process, and one or more years of teaching is generally required of graduate students. A thesis/dissertation based upon laboratory research is required. Acceptable minor fields for doctoral students include biology, chemistry, mathematics, microbiology, nutrition, pharmacology, physiology, zoology, or pharmacy concentrations different from the principal concentration selected by the student. Graduate study programs are individually planned after consideration of the student's preparation and professional objectives.

Specialized facilities of the College of Pharmacy available for graduate studies
include a clinical pharmacokinetics laboratory, a mass spectrometry laboratory, a nuclear magnetic resonance laboratory, large-scale natural product extraction equipment, computer graphics facilities, animal facilities, and well-equipped laboratories for chemical synthesis, structure elucidation, and pharmacokinetics research.


508a-508b. *Pharmacokinetics Discussion (1-1) I II Discussion related to the application of pharmacokinetic principles with case-study examples. CR. 507 for 508a, 485 for 508b. (Identical with HPHP 508a-508b)

512. Quantitative Structure-Activity Relationships (3) 1993-94 Approaches to the quantification of pharmacological actions of drugs on the basis of chemical structure.

527. Antineoplastic Drugs (2) II Discovery and development of natural and synthetic antineoplastic drugs; preclinical screening and toxicity evaluation; phase I, II, and III clinical studies in humans. P. 437b or CR.

537a-537b. *Medicinal Chemistry and Pharmacognosy (4-4) Relationships between the chemical structure and physiological activity, incompatibilities and stability of the organic and inorganic compounds obtained from natural and synthetic sources; essentials of pharmacognosy, including biologics. P. 307, CHEM 241b, 243b.

596. Seminar
a. Pharmaceutical Chemistry (1) [Rpt./5] I II
b. Pharmaceutical Chemistry Research (1) [Rpt./5] I II
c. Pharmaceutics Research (1 to 2) [Rpt./5] I II Open to majors only.
d. Pharmaceutics (1) [Rpt./5 units] I II

*May be accompanied with 400-level course.

601. Advanced Physical Pharmacy (3) II 1994-95 Applications of physical chemistry to pharmacy. P. physical pharmacy or physical chemistry course.


606. Industrial Manufacturing Pharmacy (3) II Pharmaceutics as applied to various aspects of industrial pharmacy. Field trips.


630a-630b. Advanced Organic Medicinals (3-3) 1994-95 Rational drug design, receptor site theories, mechanism of drug action, and metabolic pathways of medicinal agents; chemical and enzymatic synthesis of important pharmaceuticals. P. 437b, PCOL 471b.

632a-632b. Natural Medicinal Products (3-3) 1993-94 Origin and isolation of terpenoidal and alkaloidal drugs and other natural products of interest. P. 437b, PCOL 471b.

634. Biomedical Applications of Mass Spectrometry (3) 1993-94 Principles of mass spectrometry including instrumental design, interpretation of spectra, and applications to biomedical and related problems. P. Chem. 241b.

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**Pharmacology (PHCL)**

College of Medicine, Room 5103

(602) 626-6400

(Dean, College of Medicine)

Professors John D. Palmer, Acting Head, David S. Alberts (Internal Medicine), H. Vasken Aposhian (Molecular and Cellular Biology), Kraus Brenda, Rubin Bresler (Internal Medicine), Burnell R. Brown, Jr. (Anesthesiology), Dean E. Carter (Pharmacology and Toxicology), Thomas F. Davis, A. Jay Gandolfi (Anesthesiology, Pharmacology and Toxicology), Marilyn J. Halonen, Ryan J. Huxtable, David G. Johnson (Internal Medicine), David L. Kreulen (Physiology), Eugene Morkin (Internal Medicine, Physiology), Frank F. N.una, Garth P. R. (Surgery), William R. Roske (Internal Medicine), I. Glenn Sipes (Anesthesiology, Pharmacology and Toxicology), Henry I. Yamamura (Biochemistry)

Associate Professors John W. Bloom (Internal Medicine), Robert T. Dorr, Timothy Fagan (Internal Medicine), Laurel A. Fisher, Douglas F. Larson (Surgery), Thomas J. Lindell (Molecular and Cellular Biology)

Assistant Professors Josephine Lai, Ronald Lynch (Physiology), Andrea J. Yool (Physiology)

The Department of Pharmacology in the College of Medicine cooperates with the Department of Pharmacology and Toxicology in the College of Pharmacy, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science degree with a major in pharmacology and the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry for the Committee on Pharmacology and Toxicology for details on admission and degree requirements.

Pharmacology is a broad discipline involving the investigation of the actions of chemicals upon living material at all levels of organization. It occupies an important interface between the basic medical sciences and the clinical sciences, drawing strongly upon the former for its contribution to the latter. Research in pharmacology utilizes all appropriate techniques of modern biology from the molecular to the clinical levels. Pharmacologic knowledge is applied to the understanding of the basic mechanisms of drug action, the diagnosis, prevention, cure, or relief of the symptoms of disease and the promotion of optimal health. The emphasis on basic pharmacologic principles enables the student to develop techniques of problem-solving to keep abreast of advances in pharmacology and its applications to other sciences.

501. The Pharmacological Basis of Therapeutics (6) II Actions of chemical agents upon living material at all levels of organization, with emphasis on mechanisms of action of prototype drugs; foundation for a rational approach to human therapeutics and toxicology. P. PSIO 580, 581 and graduate course equivalent to BIOC 562 or 501. (Identical with TOX 501)

520. Clinical Pharmacology (2) I Effects of drugs on natural history of disease; drug-drug interactions; drug testing designs; drug abuse; drug literature evaluation; aspects of clinical toxicology. P. 501.

550. Drug Disposition and Metabolism (2) II Principles of absorption, distribution and excretion of drugs, with emphasis on mechanisms of drug metabolism and pharmacokinetics. P. 501, TOX 602a. (Identical with TOX 550)

551. Molecular Biology of Pharmacological Agents (3) I 1993-94 Molecular mechanism of drugs and toxins at the cellular and subcellular levels, including effects on control mechanisms, cell-cell interactions, organelles, and nucleic acid and protein synthesis. P. 501, 550, 561b. (Identical with TOX 551) Lai


576. Environmental Toxicology (3) I (Identical with TOX 576)

582. Immunotoxicology (2) I (Identical with TOX 582)

586a-586b. Introduction to Pharmacology and Toxicology Research (1-1) Introduction to basic research techniques in pharmacology and toxicology through supervised laboratory rotations; student-initiated and faculty-structured lab. exercises in modern pharmacology.

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128 Pharmaceutical Sciences—Pharmacology
Pharmacology—Pharmacology and Toxicology 129

Pharmacology and Toxicology (PCOL/TOX)
Pharmacy Building, Room 236
(602) 626-2823
(Department, College of Pharmacy)

Professors I. Glenn Sipes, Head, Timothy Bowden (Radiation Oncology), Dean E. Carter, Lincoln Chin (Emeritus), Paul F. Consoroe, James R. Halpert, Wayburn S. Jeter (Emeritus), Hugh E. Laird II, Albert L. Pichioni (Emeritus), Findlay E. Russell, Theodore Tong (Pharmacy Practice)
Associate Professor Charlene A. McQueen
Assistant Professors Cliff D. Crutchfield (Health Education), William S. Dalton (Internal Medicine), Robert T. Dorr (Internal Medicine), Daniel C. Liebler, John Regan, John Sullivan (Emergency Medicine and Pharmacology), Mark Van Ert (Health Education)

Industrial hygiene is the applied science concerned with the anticipation, recognition, evaluation, and control of chemical and physical agents that can affect health status in occupational and environmental settings. An industrial hygiene concentration is offered within the M.S. toxicology program. The concentration prepares students for professional practice in a wide range of both private and public sector organizations.

A Ph.D. degree in this discipline is awarded through the Graduate Interdisciplinary Program in Pharmacology and Toxicology.

Pharmacology (PCOL)

The Department of Pharmacology in the College of Medicine offers programs leading to the Master of Science degree with a major in pharmacology. See Pharmacology (PHCL) for details on admission and degree requirements.

In conjunction with other departments in the University, the Department of Pharmacology and Toxicology in the College of Pharmacy participates in an interdisciplinary graduate program leading to the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry under Graduate Interdisciplinary Program in Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements.

571a-571b.* Fundamentals of Pharmacology (4-4) Comprehensive study of the biochemical, physiological, and therapeutic effects of drugs, including mechanisms of drug action and drug toxicity, and drug literature evaluation. 3R, 3L. P, CR, PHPR 475a-475b and PHSC 437a-437b. (Identical with TOX 571a-571b)

572.* Nursing Pharmacology (3) I II Pharmacodynamics, pharmacology, and adverse effects of commonly used drugs, with emphasis on clinical applications. Not available for elective credit in the College of Pharmacy or graduate credit in pharmacology-toxicology doctoral programs. P, EXSS 201.

574.* Clinical Toxicology (2) I Prevention, characteristics, diagnosis and rational management of diseases caused by drug overdose, toxic household products, poisonous plants, venomous animals, environmental and industrial toxics. P, 472 or 471b, PHSC 407. (Identical with TOX 574)

596. Seminar
a. Advanced Graduate Research (1-3) [Rpt./4 units] I II (Identical with PHCL 596a, which is home)

*May be conformed with 400-level course.

800. Research (1-6)

801. The Pharmacological Basis of Therapeutics (6) II

805. Human Neuroscience (6) I II (Identical with ANAT 805)

Professors I. Glenn Sipes, Head, Timothy Bowden (Radiation Oncology), Dean E. Carter, Lincoln Chin (Emeritus), Paul F. Consoroe, James R. Halpert, Wayburn S. Jeter (Emeritus), Hugh E. Laird II, Albert L. Pichioni (Emeritus), Findlay E. Russell, Theodore Tong (Pharmacy Practice)
Associate Professor Charlene A. McQueen
Assistant Professors Cliff D. Crutchfield (Health Education), William S. Dalton (Internal Medicine), Robert T. Dorr (Internal Medicine), Daniel C. Liebler, John Regan, John Sullivan (Emergency Medicine and Pharmacology), Mark Van Ert (Health Education)

Pharmacology and Toxicology (PCOL/TOX)
Pharmacy Building, Room 236
(602) 626-2823
(Department, College of Pharmacy)

Professors I. Glenn Sipes, Head, Timothy Bowden (Radiation Oncology), Dean E. Carter, Lincoln Chin (Emeritus), Paul F. Consoroe, James R. Halpert, Wayburn S. Jeter (Emeritus), Hugh E. Laird II, Albert L. Pichioni (Emeritus), Findlay E. Russell, Theodore Tong (Pharmacy Practice)
Associate Professor Charlene A. McQueen
Assistant Professors Cliff D. Crutchfield (Health Education), William S. Dalton (Internal Medicine), Robert T. Dorr (Internal Medicine), Daniel C. Liebler, John Regan, John Sullivan (Emergency Medicine and Pharmacology), Mark Van Ert (Health Education)

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A Ph.D. degree in this discipline is awarded through the Graduate Interdisciplinary Program in Pharmacology and Toxicology.

Pharmacology (PCOL)

The Department of Pharmacology in the College of Medicine offers programs leading to the Master of Science degree with a major in pharmacology. See Pharmacology (PHCL) for details on admission and degree requirements.

In conjunction with other departments in the University, the Department of Pharmacology and Toxicology in the College of Pharmacy participates in an interdisciplinary graduate program leading to the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry under Graduate Interdisciplinary Program in Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements.

571a-571b.* Fundamentals of Pharmacology (4-4) Comprehensive study of the biochemical, physiological, and therapeutic effects of drugs, including mechanisms of drug action and drug toxicity, and drug literature evaluation. 3R, 3L. P, CR, PHPR 475a-475b and PHSC 437a-437b. (Identical with TOX 571a-571b)

572.* Nursing Pharmacology (3) I II Pharmacodynamics, pharmacology, and adverse effects of commonly used drugs, with emphasis on clinical applications. Not available for elective credit in the College of Pharmacy or graduate credit in pharmacology-toxicology doctoral programs. P, EXSS 201.

574.* Clinical Toxicology (2) I Prevention, characteristics, diagnosis and rational management of diseases caused by drug overdose, toxic household products, poisonous plants, venomous animals, environmental and industrial toxics. P, 472 or 471b, PHSC 407. (Identical with TOX 574)

596. Seminar
a. Advanced Graduate Research (1-3) [Rpt./4 units] I II (Identical with PHCL 596a, which is home)

*May be conformed with 400-level course.

800. Research (1-6)

801. The Pharmacological Basis of Therapeutics (6) II

805. Human Neuroscience (6) I II (Identical with ANAT 805)
drugs on the nervous system, including their actions at receptors and their influence on synthesis, storage, and release of neurotransmitters. P, PHCL 501 or PCOL 471b, 561a, 596. (Identical with PHCL 653 and TOX 653)

695. Colloquium
   a. Research Conference (1-4) [Rpt.] I II
   b. Seminar

696. Seminar
   a. Student Research (1) [Rpt./4] II (Identical with PHCL 696a, which is home)

815. Pharmacy Subspecialty
   I. Research (5) I II S 15-30L. P or CR, 10 units of 810. (Identical with PHPR 815I, which is home.)

Toxicology (TOX)

The Department of Pharmacology and Toxicology in the College of Pharmacy offers a curriculum leading to the Master of Science degree with a major in toxicology. Prerequisite to admission is the completion of a bachelor's degree including one year each of analytical chemistry, biological science, and organic chemistry and a semester of instrumental analysis. Three letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Required courses for the graduate program are BIOC 560 (or 562a-562b), PSIO 580-581, PHCL 501 (or PCOL 571a-571b), PCOL 574 (or V SC 523), 565, 601, 602a-602b, 696a. Electives are available to complement the various areas of toxicology. A thesis is required.

Industrial Hygiene Concentration: Admission requirements for the industrial hygiene concentration are identical to those for the Master of Science degree in toxicology. Required courses for the industrial hygiene concentration are 565, 560, 554, 581, 586, 587, 596a, and FCM 596. A summer internshp is recommended, and a thesis is required.

For information on the Doctor of Philosophy degree with a major in pharmacology and toxicology, see the entry under Graduate Interdisciplinary Program in Pharmacology and Toxicology elsewhere in this catalog.

501. The Pharmacological Basis of Therapeutics (6) II (Identical with PHCL 501) P, PSIO 601 and graduate course equivalent to BIOC 801.

502. Industrial Hygiene Instrumentation and Analysis (2-4) I (Identical with OSH 502)

508.* Insectic Toxicology (3) II 1993-94 (Identical with PCOL 508)

509. Statistics for Research (4) I II (Identical with Stat. 565)

510.* Physical Exposures (3) I (Identical with OSH 510)

512. Hazardous Materials (2-4) I (Identical with OSH 512)

523.* Mechanisms of Disease (4) II (Identical with V SC 523)

550. Drug Disposition and Metabolism (2) II (Identical with PHCL 550)

551. Molecular Biology of Pharmacological Agents (3) I 1993-94 (Identical with PHCL 551)

554. Industrial Toxicology and Chemical Exposures (2-4) I Principles of toxicology related to industry; dose response; mechanisms of toxicity; hazard evaluation principles; toxicology of major classes of industrial compounds. P, 6 units each of biological science and organic chemistry.

560. General Biochemistry (5) I II (Identical with BIOC 560)

562a-562b.* Biochemistry (3-3) (Identical with BIOC 562a-562b)

566.* Physiology Laboratory (3) II (Identical with ECOL 566)

571a-571b. * Fundamentals of Pharmacology (4-4) (Identical with PCOL 571a-571b)

574.* Clinical Toxicology (2) I II (Identical with PCOL 574)

576. Environmental Toxicology (3) II Toxicity of natural toxins and of agricultural and industrial chemicals, with emphasis on air and water pollutants; decision-making in environmental issues. P, 6 units of biology and organic chemistry; CHEM 325, 326. (Identical with ENTO 576 and PHCL 576)

580.* Human Physiology (4) II (Identical with PSIO 580)

581. Physiology Laboratory (1) I (Identical with PHCL 581)

582. Immunotoxicology (2) I Broad overview of the immune system, with emphasis on how chemicals affect the immune system (immunomodulation) and the role of the immune system in chemical-induced tissue injury/allergic responses. P, 602, MICR 419R, 567. (Identical with MBIM 582 and PHCL 582)

585.* Industrial Ventilation (3) II Design and evaluation of industrial ventilation systems. Emphasis is on level evaluation of industrial contaminants. Five laboratory exercises and course design project. 3R, 1L.

586.* Fundamentals of Industrial Hygiene (3) I (Identical with OSH 586)

587.* Advanced Industrial Hygiene and Safety (3) II (Identical with OSH 587)

596. Seminar
   a. Advanced Toxicology (1-2) [Rpt./3] I
   b. Current Concepts in Toxicology (1-2) [Rpt./3] II

*May be convened with 400-level course.

601. Analytical Instrumentation and Techniques (2-4) I Lecture and laboratory in the qualitative and quantitative determination of toxic substances in the environment and body fluids. Modern instrumental techniques will be employed whenever appropriate. Lecture may be taken separately by non-majors. P, 6L. P, CHEM 325, 326. (Identical with PHCL 601)

602a-602b. Biototoxicology (3-1) 602a: I Lecture. Mechanisms of organ directed toxicities in animals. Chemical carcinogenesis, teratogenesis and mutagenesis. Open to non-majors. P, two semesters of ecology 602b: II Laboratory. Proper use of animals in toxicology and pharmacology research; focuses on organ specific toxicities. (Identical with PHCL 602a-602b)

610. Topics in Advanced Toxicology (1-3) I II Current developments in toxicology including: chemical carcinogenesis, mutagenesis and teratogenesis; behavioral toxicology; inhalation toxicology; toxinokinetics; metabolism and environmental toxicology. P, 601, 602a-602b.

620. Principles of Pharmacology (3) I (Identical with PHCL 620)

653. Neuropharmacology (3-4) II (Identical with PCOL 653)

Pharmacology and Toxicology

College of Medicine, Room 5103
(602) 626-7912
Graduate Interdisciplinary Program in Pharmacology and Toxicology

Committee:

Professors David L. Kreulen, Chair, David S. Alberts (Cancer Center), H. Vasken Apooshian (Molecular and Cellular Biology), G. Tim Bowden (Radiation Oncology), Klaus Brendel (Pharmacology), Rubin Bressler (Internal Medicine), Burrell R. Brown (Anesthesiology), Dean E. Carter (Pharmacology and Toxicology), Paul F. Consore (Pharmacology and Toxicology), Thomas P. Davis (Pharmacology), A. Jay Gandolfi (Anesthesiology), Marilyn Halonen (Pharmacology), James R. Halpert (Pharmacology and Toxicology), Ryan J. Huxtable (Pharmacology), David G. Johnson (Internal Medicine), Hugh E. Laird, II (Pharmacology and Toxicology), - Eugene Morkin (Heart Center), John D. Palmer (Pharmacology), Frank Porreca (Pharmacology), Garth Powis (Cancer Center), Charles W. Putnam (Surgery), William R. Roeske (Internal Medicine), Findlay E. Russell (Pharmacology and Toxicology), I. Glenn Sipes (Pharmacology and Toxicology), Henry I. Yamamura (Pharmacology)

Associate Professors William S. Dalton (Pharmacology), Edward D. French (Internal Medicine), Laurel Fisher (Internal Medicine), Robert D. Dorr (Cancer Center), Timothy C. Fagan (Internal Medicine), Findlay E. Russell (Pharmacology and Toxicology), Chen. A. McQueen (Pharmacology and Toxicology), John B. Sullivan (Surgery)
The Graduate Interdisciplinary Program in Pharmacology and Toxicology offers a graduate program leading to the Doctor of Philosophy degree with a major in pharmacology and toxicology. The program has a faculty from the departments of Pharmacology, Pharmacology and Toxicology, Anesthesiology, Cancer Center, Molecular and Cellular Biology, Pediatrics, Radiation Oncology, Surgery, Internal Medicine, and the Arizona Research Laboratory.

Admission requires the completion of a bachelor's degree with a major in chemistry, biology, pharmacy, or other related science. Minimal prerequisites include one year each of biology, organic chemistry, and physics and course work in mathematics through integral calculus. Applicants must submit scores on the Graduate Record Examination. Correspondence may be directed to the Chairperson of the Graduate Interdisciplinary Program in Pharmacology and Toxicology.

The University also offers separate M.S. programs; one in Pharmacology, another in Toxicology. Graduate study programs are individually planned after consideration of the student's preparation and professional objectives. A dissertation/thesis is required.

For course descriptions, see Pharmacology (College of Medicine) and Pharmacology and Toxicology (College of Pharmacy) elsewhere in this catalog.

**Pharmacy Practice (PHPR)**

Pharmacy Building, Room 318  
(602) 626-5730

Professors John E. Murphy, Head, Jack R. Arndt, J. Lyle Bootman, Michael Mayersohn (Pharmaceutical Sciences), Gary H. Smith, Theodore G. Tong, Samuel H. Yalkowsky (Pharmaceutical Sciences)

Associate Professors Edward P. Armstrong, Stephen Joel Coons, Martha P. Fankhauser, Marie E. Gardner, Martin D. Higbee, Michael D. Katz, Paul E. Nolan, Patricia M. Plezia

Assistant Professors Suzanne Campbell, Hsiao-Hui (Sherry) Chow (Pharmaceutical Sciences), JoLaine R. Draugalis, Victor A. Elseberry, Brian L. Erstad, Brian G. Ortmeier, Karen Ann Sauer

The Department of Pharmacy Practice offers a program leading to the Master of Science degree with a major in pharmacy with concentrations in institutional management and the social and administrative sciences. Graduate study in the social and administrative sciences leading to the Doctor of Philosophy degree with a major in pharmacy is offered in this department.

A bachelor's degree in pharmacy or a Doctor of Pharmacy degree is prerequisite to admission to the institutional management concentration. Admission preference for graduate study in the social and administrative sciences is given to applicants who hold an undergraduate degree in pharmacy. Applicants with bachelor's degrees in areas other than pharmacy will also be considered.

Teaching is a part of the graduate learning process, and one year of teaching or more is generally required of all graduate students. A thesis is required for the master's degree. Acceptable minor fields for doctoral students include economics, education, management and policy, or marketing.

502* Pharmacokinetics (4) I (Identical with PHSC 507)

508a-508b* Pharmacokinetics Discussion (1-1) I II (Identical with PHSC 508a-508b)

511. Pharmacy Management (3) I History, organization and administration of pharmaceutical services within the institutional environment.

512. Advanced Pharmacy Management (3) II Application of management principles to problem-solving and decision-making techniques in the provision of pharmaceutical services within the institutional environment. Field trips. Open to majors only. P. 511.

542* Professional Practice Management (3) I Management of professional situations and the interaction among patients, colleagues, and other health-care providers, with application to institutional, community, and clinical pharmacy practice. P. 445.

545. Medication Use and the U.S. Health Care System (3) I An overview of the U.S. health care system and the consumers, providers, payers, and regulators that comprise it. The role of pharmacy and pharmacists within the health care system will be explored, including an examination of social, behavioral and economic factors associated with the prescribing, dispensing, and use of medications.

547* Perspectives in Geriatrics Laboratory (1) I II P, CR, 448. (Identical with GERO 547 and NPS 547)

548* Perspectives in Geriatrics (2) II Multidisciplinary approach to the health-care needs of the elderly, including medication use, nutrition, health care agencies and roles of individual health care professionals. Open to nonmajors. P, CR, 447 for nonmajors. (Identical with GERO 548)

561*. Methodology in Pharmacy Research and Drug Literature Evaluation (3) II Application of research design, statistical methods, evaluation techniques, and ethical dimensions to critically evaluate published literature, research reports and proposals. P, STAT 260.

583*. Perspectives of Cancer Care for Health Professionals (3) S (Identical with NURS 583)

589. Clinical Pharmacotherapy of Mental Disorders (2) I A multidisciplinary approach to clinical psychopharmacology, therapeutics, and diagnosis of mental disorders for health professionals.

596. Seminar
  a. Pharmacy Administration (1) [Rpt./5] I
  b. Pharmacy Administration Research (1) [Rpt./5] II

*May be convened with 400-level course.

611. Pharmacy and Its Environment (3) I Cultural, social, behavioral, and organizational foundations of pharmacy, including the development of the present state of practice.

612. Issues in Pharmacy Practice Research (3) I Survey of research methodology for studying administrative, social and behavioral aspects of health care and pharmacy practice; strategy for selecting and modifying existing research tools for particular purposes.

621. Pharmaceutical Marketing (3) I II Socioeconomic factors in the development, production, and distribution of drugs.

635. Issues in Rural Health Care (3) I II (Identical with NURS 635)

694. Practicum
  a. Clinical Clerkship (1-15) [Rpt.] I II
  b. Administrative Clerkship (1-15) [Rpt.] I II

695. Colloquium
  a. Research in Gerontology (1) I II (Identical with GERO 695a, which is home)

800. Pharmacy Practice Project (1) I II Individual pharmacy practice research not related to a thesis or dissertation. Open only to students enrolled in Doctor of Pharmacy program.

803. Pharmacy Clinical Clerkship (5) I II SP available only after completion of all required and elective didactic coursework in the first 3 professional years.

  a. Community Pharmacy Practice
  b. Institutional Pharmacy Practice
  c. Ambulatory Pharmacy Practice
  d. Drug Information Practice
  e. Adult Acute Care Pharmacy Practice

Note: 803a-e are six-week courses.

810. Pharmacy Clerkship (5) [Rpt./10 units] I II SP, available only after completion of all required and elective didactic coursework in the first three professional years.

  a. Internal Medicine
  b. Surgery
c. Pediatrics
d. Geriatrics/Gerontology
e. Outpatient Practice
f. Emergency Services
g. Acute Care
h. Clinical Pharmacokinetics
i. Psychopharmacology/Neurology
j. Special Institutionology

Note: 810a-k are six-week courses.

815. Pharmacy Subspeciality (5) I II S F, available only after completion of all required and elective didactic coursework in the first 3 professional years.

896. Seminar

a. Pharmacy Practice (1) I II

Philosophy (PHIL)

Social Sciences Building, Room 213
(602) 621-3129

Professors Ronald D. Milo, Head, Allen Buan, Ken C. Byerly, Robert L. Caldwell (Emeritus), Robert L. Caldwell (Emeritus), Joseph L. Cowan, Robert Cummins, Joel Feinberg, Alvin L. Goldman, Jean Hampton, Robert L. Harnish, Henning Jensen (Emeritus), Keith Lehrer, J. Christopher Maloney, John L. Pollock, Francis V. Raab (Emeritus), Margaret Reimer, David Owen, Margaret Reimer

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in philosophy. In addition to the traditional areas of philosophy, concentrations are available that bridge philosophy with other disciplines such as law or cognitive science.

Applicants for the graduate program should normally have completed 30 units of undergraduate work in philosophy. In addition to application materials required by the Graduate College, applicants should submit to the department a copy of their completed application, copies of transcripts (these need not be official), three letters of recommendation from philosophy instructors, GRE general aptitude scores, and a sample of their written philosophy work.

Degrees

Master of Arts: A student must demonstrate proficiency in logic, and in addition must pass at least one course in each of the following three areas: history of philosophy, metaphysics and epistemology, and moral philosophy. A final examination must be passed, based on a research paper in an area chosen by the student. The student's program of study is designed individually. No thesis is required.

Doctor of Philosophy: A student must pass two courses in each of the following four distribution areas: (1) logic (required), philosophy of language, and philosophy of science; (2) history of philosophy; (3) epistemology and metaphysics; and (4) moral, social, and legal philosophy. A substantial proportion of one's courses must be at the seminar level. Students must pass a qualifying exam, based on a research paper. In addition, a preliminary exam must be passed in areas of the student's choice, and a doctoral dissertation is required. Further details about requirements and procedures can be obtained from the department. Teaching assistantships are available for qualified students.

503.* Foundations of Mathematics (2-2) 1994-95 (Identical with MATH 503)

512.* Readings in Greek Philosophy (2) [Rpt.] (Identical with GRK 512)

513a-513b.* Symbolic Logic (3-3) 513a: Intermediate propositional logic and quantification theory, natural deduction, axiom systems, elementary metatheorems, introduction notions of modal logic, selected topics in philosophy of logic. 513b: Advanced propositional logic and quantification theory; metatheorems on consistency, independence, and completeness; set theory, number theory, and modal theory; recursive function theory and Goedel's incompleteness theorem.

514.* Philosophical Logical (3) Introduction to modal logic; problems of interpretation and application; extensions to such areas as tense logic, epistemic logic, deontic logic.


521.* Philosophy of the Biological Sciences (3) Laws and models in biology, structure of evolutionary theory, teleological explanations, reductionism, sociology. (Identical with ECOL 521)

522.* Linguistic Semantics and Lexicology (3) II 1994-95 (Identical with LING 522)

523a-523b.* Philosophy of the Physical Sciences (3-3) 523a: Theories and models. Measurement, experimentation, testing hypotheses. Philosophical problems concerning explanation, causation and laws of nature. 523b: Philosophical problems of space, time and motion. Topics may include the nature of geometrical knowledge, the philosophical impact of relativity theory, absolute versus relative conceptions of space and time.

524.* Philosophy of Social Sciences (3) Theories, concepts, and forms of understanding in the social sciences. Possible topics: rational choice and decision at the individual and social levels; democracy; and market mechanisms. P, one course in philosophy.

530a-530b.* Ethical Theory (3-3) 530a: Metatheories—meaning of moral terms, relativism, subjectivism, ethics and science, social contract theory. 530b: Normative ethics—Utilitarianism, egoism, rights, natural law, justice, deontological duties, blameworthiness and excuses.

533.* Aesthetics (3) Classical and contemporary theories of art; the aesthetic experience, form and content, meaning, problems in interpretation and criticism of works of art.

534.* Social and Political Philosophy (3) Fundamental concepts of politics; leading social and political theories, such as anarchism, social contract, Marxism.

536.* Games and Decisions (3) Classical theory of subjective probability, utility, and rational choice, with applications to games theory and social welfare theory. P, MATH 119.

538a-538b.* Philosophy of Law (3-3) 538a: Nature and validity of law; law and morality, judicial reasoning, law and liberty. 538b: Problems about justice, compensation and contracts and/or responsibility and punishment, (Identical with PHIL 538a, 538b).

540.* Metaphysics (3) Topics include free will and determinism; causation; personal identity; necessity and essence; truth, realism and ontology.

541.* Theory of Knowledge (3) Critical examination of some of the major problems concerning evidence, justification, knowledge, memory, perception and induction.

542.* Knowledge and Cognition (3) I Issues in philosophy and psychology of knowledge, with emphasis on cognitive mechanisms. Perception, memory, concepts, mental representation, problem-solving, reasoning and rationality. P, two philosophy courses.

543.* Knowledge and Society (3) I II Social and interpersonal processes affecting the acquisition and diffusion of knowledge. Emphasis on philosophical perspectives, with interdisciplinary borrowings. P, one philosophy course.

550.* Philosophy of Mind (3) Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, emotion, memory and action.

551.* Philosophy and Psychology (3) Investigation of philosophical issues arising from
current work in psychology including perception, reasoning, memory, motivation and action.

555. * Philosophy and Artificial Intelligence (3) Interdisciplinary problems lying at the interface of philosophy and artificial intelligence (Identical with PSYC 555)

563. * Philosophy of Language (3) Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical form. (Identical with LING 563)

564. Formal Semantics (3) I (Identical with LING 564)

565. * Pragmatics (3) II Study of language use, its relationships to language structure and context; topics such as speech acts, presupposition, implication, performatives, conversations. (Identical with LING 565)


570. * Greek Philosophy (3) [Rpt./1] Topics in Greek philosophy. May be selected from the pre-Socratics, Socrates, Plato, Aristotle and post-Aristotelian philosophy. (Identical with CLAS 570)

571a-571b. * Rationalism and Empiricism (3-3) 571a: Rationalists of the 17th and 18th centuries: Descartes, Spinoza, Leibniz, and Kant. 571b: Empiricists of the 17th and 18th centuries: Locke, Berkeley, Hume.

572a-572b. * Ancient Philosophy (3-3) [Rpt.] 572a: A philosophical introduction to the major works of Plato. 572b: A philosophical introduction to the major works of Aristotle. (Identical with CLAS 572a-572b)

573. * Natural Language Processing (3) II 1994-95 (Identical with LING 573)

596. Seminar
   a. Ethics (3) [Rpt./2]
   b. Metaphysics (3) [Rpt./2]
   c. Epistemology (3) [Rpt./2]
   d. Social and Political Philosophy (3) [Rpt./2]
   e. Philosophy of Law (3) [Rpt./2]
   f. Philosophy of Mind (3) [Rpt./2]
   g. Philosophy of Language (3) [Rpt./2]
   h. History of Philosophy: Ancient (3) [Rpt./2]
   i. History of Philosophy: Recent (3) [Rpt./2]
   j. Philosophy and Cognitive Science (3) [Rpt./2]

*May be convened with 400-level course.

**Physics (PHYS)**

PAS Building, Room 260
(602) 621-6824


Associate Professors Anna Hasenfrat, Ke-Chiang Hsieh, Sumit Mazumdar, Fulvio Melia, Michael A. Shupe, Daniel Stein, Douglas Touissant, Jay E. Treat (Emeritus)

Assistant Professors Geoffrey E. Forden, Kenneth A. Johns, Ina Sarcevic, Wing Y. Tam

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in physics. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in physics. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Prerequisites for admission to full graduate standing are thirty semester units of undergraduate work in physics. These will normally include the following work beyond introductory physics: appropriate laboratory work; one semester each of mechanics, thermodynamics, and optics; two semesters of electricity and magnetism; and two semesters of modern physics including quantum mechanics. All applicants must submit scores on the aptitude and advanced tests of the Graduate Record Examination.

An advisor is assigned to each graduate student to help plan a program for the advanced degree. Students without deficiencies are required to take, during the first week of classes, a qualifying comprehensive examination. This diagnostic examination covers undergraduate physics only; and the results will be used to help in determining an appropriate course of studies. Two attempts to pass this examination are permitted. Experience in teaching is an essential part of graduate training in physics. Graduate students are required to teach an amount to be determined on an individual basis by the graduate adviser and the department as a whole. Graduate students are required to take 695 until the preliminary examination is passed.

**Degrees**

**Master of Science:** At least fifteen of the required thirty units of graduate work must be in physics and must include 536, 511 and 515a or the equivalent. All students must satisfy one of the following options: (1) write a thesis (for which up to six units may be allowed); and pass an oral examination; (2) take 21 of the 30 required graduate units in physics and pass a comprehensive final oral examination; (3) pass the written and oral parts of the preliminary examination for the Doctor of Philosophy degree.

**Doctor of Philosophy:** Each student must complete at least 36 units of graduate work in physics exclusive of the dissertation and the supporting (minor) work. Courses will be chosen in consultation with the graduate adviser. Each student must complete four of the following courses: 513, 525, 535, 551, 559 or 561, 579a or 579b, 581 and 685. In addition, at least two of the four courses must be from the subset of courses 535, 551, 559 or 561 and 581. Note that only one of the courses 559 and 561 and one of the courses 579a and 579b can be counted as part of the required four courses. The preliminary examination will cover classical mechanics, electromagnetic theory, relativity, statistical mechanics, experimental physics, quantum mechanics, modern physics, and questions on current developments. The courses 511, 515a-515b, 528, and 570a-570b indicate the areas covered in the examination and the level of understanding expected of the student. The preliminary examination must be taken, at the latest, during the fifth semester (excluding summer sessions) of residence. It is expected that the dissertation, based upon original research, will be published in a refereed journal. The minor work may be satisfied within the Department of Physics and, in this case, some courses taken in other departments may be used as well. An additional twelve units of work, chosen in consultation with the graduate adviser, are required for the minor in physics. Proficiency in one foreign language is required. Information on methods of demonstrating proficiency may be obtained from the Department of Physics.

Students intending to minor in physics (to supplement a major in another department) should consult the
530. Introduction to Biophysics (2) I Concepts and experimental techniques of molecular biophysics; physical properties of biological macromolecules and cell organelles, optical interactions, macromolecular transitions, molecular mechanism or regulation. P. 102b, CHEM 103a-103b. (Identical with MBIM 530)

531. Biophysical Theory (2) II Physical concepts and theories describing biomolecular structure and function, molecular evolution, limits to structure, symmetry, oligomer and virus structure, organelle structure and function. (Identical with MBIM 531)

533.* Physics Demonstrations (1-3) II Introduction to teaching materials and laboratory demonstrations illustrating principles of classical and modern physics, with emphasis on inexpensive techniques and direct experience. Advanced degree credit available for nonmajors only. P. two semesters of physics.

535. Advanced Atomic Physics (3) II 1994-95 Details of atomic structure, interactions of atoms with electromagnetic fields, electrons and ions; techniques for calculating unperturbed and perturbed energy levels, transition probabilities, and atomic interaction cross sections. P. 511, 515b, 570b.

536.* Applications of Introductory Quantum Theory (3) I II Applications of quantum theory to molecules, atomic nuclei, elementary particles and solid states. P. 433.

540a-540b.* Atomic and Molecular Spectroscopy: for Experimentalists (3-3) Experimental techniques to generate, analyze and detect photons from X-ray to IR; interpretation of spectra from gases, liquids, solids and biological macromolecules; light scattering, polarization. P. 330 or 112b. (Identical with OPTI 540a-540b)

543. Laser Physics (3) I (Identical with OPTI 543)

545. Experimental Physics 545a-545b-545c are three five-week lecture courses; none is prerequisite to any other.

a.* Experimental Spectroscopy (1) I I II Laboratory experiments with spectroscopic sources, spectrometers, instrument functions, detectors, light collection optics, spectral recording and analysis. P. 511, 110, 116, 121, or consult department before enrolling.

b.* Experimental Acoustics (1) I I II Laboratory experiments with sound sources, oscilloscopes, spectrum analyzers, sound level meters, filters, musical instruments, recording, room acoustics. P. 110, 116, 121, or consult department before enrolling.

c.* Experimental Microscopy, Light Scattering and Optics of Small Particles (1) I I II Laboratory experiments with microscopes and polarized scattered light to characterize small particles and surfaces, optical constants, lasers remote sensing. P. 110, 116, 121, or consult department before enrolling.

550. Introductory Nuclear Physics (3) II Basic concepts of nuclear physics: structure and stability of nuclei; nuclear forces; stable and unstable nuclei; decay of unstable systems; nuclear radiation characteristics. P. 330 or 112b, MATH 254.

551. Nuclear Physics (3) I Theory of nuclear systems, including stability, decay, nuclear forces, scattering, reactions, structure, and interaction with electromagnetic radiation. P. CR, 570a-570b.


556a-556b. Electrodynamics of Conducting Fluids and Plasmas (3-3) 1992-93 (Identical with PTYS 556a-556b)


560.* Introductory Solid-State Physics (3) I II Properties of solids from molecular, atomic, and electronic theory; electric, magnetic, and thermal properties of metals, insulators, and semiconductors; free electron and band theories. P. 330 or 112b.

561. Physics of the Solid State (3) I II Elementary excitations in solids, phonons, electrons and holes, excitons, birefringence, interaction of light with semiconductors, polaritons, high excitation phenomena, dielectric formalism of optical response, many-body effects in a Coulomb system. P. 460, 570, or OPTI 507 recommended but not formally required. (Identical with OPTI 561)

570a-570b. Quantum Mechanics (3-3) Principles of quantum mechanics; wave mechanics and matrix mechanics; applications to atomic structure and spectroscopy. P. 475a-475b recommended but not required.

571. Symmetry Groups in Physics (3) I Algebraic results of the theory of groups which find repeated applications in atomic, molecular, and nuclear physics. Continuous groups, Lie algebras, discrete groups, irreducible tensors. P. 570a-570b.

575a-575b.* Methods of Mathematical Physics (3-3) Vector and tensor analysis; differential and integral equations; Green's functions; variational techniques; linear operator theory; with emphasis on physical applications. P. 410, MATH 254, CR, 415a-415b.

577a-577b. Theory of Relativity (3-3) 1994-95 Special theory of relativity and its application to mechanics and electrodynamics, tensor calculus and general relativity; relativistic astrophysics and cosmology. P. 475b.

579a-579b. Advanced Relativistic Quantum Mechanics (3-3) Continuous groups; scattering theory; relativistic wave equations; quantum electrodynamics, Feynman diagrams, dispersion theory, renormalization; strong and weak interactions. P. 515b, 570b.

580a-580b. Quantum Field Theory (3-3) 1993-94 Meaning of quantized fields; symmetry principles, free fields; general properties of interactions and peculiarities of electrodynamics and gravity. P. 570b, 577a.

581. Elementary Particle Physics (3) I Production, interaction, and decay of mesons, baryons and leptons; high energy scattering of elementary particles; particle classification and symmetries; theoretical interpretation. P. 436.

582. High Energy Astrophysics (3) II 1993-94 (Identical with ASTR 582)
585. Stellar Pulsation (1-3) [Rpt./5] I II Stellar pulsation, the solar atmosphere, solar seismology and long-term solar variability related to climate.

586. Techniques in Particle Physics (3) II 1994-95 Classification of elementary particles and their interactions with matter, relativistic kinematics, detectors, data acquisition techniques, statistical techniques, analysis of experiments, cosmic radiation, and accelerators.

589. Topics in Theoretical Astrophysics (3) [Rpt.] I Current topics in theoretical astrophysics in depth, with emphasis on the methodology and techniques of the theorist and the cross-disciplinary nature of astrophysics theory. Example subjects are nuclear astrophysics, hydrodynamics, transient phenomena, planetary interiors and atmospheres, neutron stars, jets, and the evolution of star clusters. (Identical with ASTR 589 and PTYS 589)

596. Seminar
a. Current Problems in Molecular Biology (1) I II [Rpt.] (Identical with MBIM 596a)
b. The Physics of Thin Films (3) I P, 460.
c. Topics in Colliding Beam Physics (3) [Rpt./9 units] I P 570a-570b

*May be convened with 400-level course.

643. Quantum Optics (3) II 1992-93 (Identical with OPTI 643)

685. Graduate Physics Laboratory (3) [Rpt./2] II Introduction to modern research methods and experiments. Problems in low-temperature physics; solid-state, atomic, and nuclear spectroscopy; computer-based data acquisition and analysis; solar-energy physics; and others.

695. Colloquium
a. Current Problems in Physics (1) [Rpt./4 units] I II

697. Workshop
a. Problems in Computational Science (3) [Rpt./1] I II (Identical with MATH 697a, which is home)

Physiological Sciences
1010 North Martin
Tucson, AZ 85721
(602) 326-0077

Graduate Interdisciplinary Program in Physiological Sciences

Committee:
Professors Roger M. Enoka, Chair (Exercise and Sport Sciences), Ronald E. Allen (Animal Sciences), Eldon J. Braun (Physiology), William H. Dantzler (Physiology), Darrel E. Goll (Animal Sciences), Robert W. Gore (Physiology), Joseph F. Gross (Emeritus), Raphael P. Gruener (Physiology), David J. Hartshorne (Animal Sciences), John G. Hildebrand (Division of Neurobiology, Arizona Research Laboratories), Paul C. Johnson (Physiology), Murray A. Katz (Internal Medicine), Otakar Koldovsky (Pediatrics), David L. Kreulen (Pharmacology), Richard J. Lemen (Pediatrics), Timothy G. Lohman (Exercise and Sport Sciences), Robert S. McCuskey (Anatomy), Eugene Morkin (Internal Medicine), William R. Roeseke (Internal Medicine), Timothy W. Semb (Physiology), Douglas G. Stuart (Physiology), Charles M. Tipton (Exercise and Sport Sciences), Marc E. Tischler (Biochemistry), Stuart K. Williams (Surgery), Stephen H. Wright (Physiology)

Associate Professors Edmund A. Arbas (Division of Neurobiology, Arizona Research Laboratories), Janis M. Burt (Physiology), Laurel A. Fisher (Pharmacology), Robert J. Gillies (Biochemistry), Patricia B. Hoyer (Physiology), Richard B. Levine (Division of Neurobiology, Arizona Research Laboratories), Paul F. McDonagh (Surgery), Wayne J. Morgan (Pediatrics), Catherine Racowsky (Obstetrics/Gynecology), David J.A. Vleck (Ecology and Evolutionary Biology), Mark E. Wise (Animal Sciences)

Assistant Professors Parker B. Antin (Animal Sciences), Ralph F. Fregosi (Exercise and Sport Sciences), Erik J. Henriksen (Exercise and Sport Sciences), Barry Komm (Physiology), Gail F. Koshland (Physiology), Kevin C. Kregel (Exercise and Sport Sciences), Howard Y. Lien (Internal Medicine), Ronald M. Lynch (Physiology), Ana M. Pajor (Physiology), John W. Regan (Pharmacology and Toxicology), Andrea J. Yool (Physiology)

The interdisciplinary Committee on Physiological Sciences offers graduate work leading to the Doctor of Philosophy degree with a major in physiological sciences. The Master of Science degree is offered only in rare instances when individuals qualified to study for the Ph.D. are forced to terminate their graduate education. Research training is an integral part of the Ph.D. program. The research areas of the faculty in the program include: cellular and transport mechanisms; circulation and respiration, including microcirculation; comparative physiology; endocrinology; exercise physiology; gastrointestinal physiology; muscle physiology; neural mechanisms, including motor control and neuroendocrinology; renal mechanisms; and reproductive and developmental mechanisms.

Applicants for the Ph.D. program in physiological sciences should hold a bachelor's degree in the physical or biological sciences, engineering, mathematics or other suitable fields. They should have completed one year of physics (including laboratory), mathematics through calculus (two semesters), biochemistry, and one semester of statistics (400 level or above). Physical chemistry and differential equations are not required but are highly desirable, as is familiarity with microcomputers and a programming language. An introductory course or readings in biology or zoology is advisable for physical science majors. The Graduate Record Examination and three letters of recommendation are required to assist in evaluation of applicants.

In the first year, students in the program take a core sequence of courses including Cell Physiology, PSIO 503; and Systems Physiology, PSIO 601. Individual programs of study are determined in conjunction with the student's major advisor and the Graduate Program Committee. Considerable flexibility is possible so that the needs of each student can be best served. A wide variety of courses is available, including courses offered by the departments of Animal Sciences, Biochemistry, Ecology and Evolutionary Biology, Exercise and Sport Sciences, Nutrition and Food Science, Physiology, and Veterinary Science. Details of these courses may be found in listings of the relevant departments in this catalog.

Physiology (PSIO)

Arizona Health Sciences Center,
Room 4103
(602) 626-7642

(College of Medicine)


Associate Professors Edmund A. Arbas (Division of Neurobiology, Arizona Research Laboratories), Janis M. Burt, Andreas M. Goldner (Emeritus), Patricia B. Hoyer, Richard B. Levine (Division of Neurobiology, Arizona Research Laboratories), Paul McDonagh (Surgery), Wayne J. Morgan (Pediatrics), L. Claire Parsons (Nursing), Stuart Williams (Surgery)

Assistant Professors Ann L. Baldwin, Gail F. Koshland, Richard J. Lemen (Pediatrics), Y. H. Howard Lien (Inter-
nal Medicine), Ronald M. Lynch (Pharmacology), Ana M. Fajer, Mark E. Wise (Animal Sciences), Andrea M. Yool (Pharmacology)

The Department of Physiology teaches and does scholarly work on physiological mechanisms of significance to medicine. In both teaching and research, the orientation of the department is broad, encompassing single cell, organ, and total body function.

The Department of Physiology participates in offering a program of instruction leading to the Doctor of Philosophy degree with a major in physiological sciences through the Graduate Interdisciplinary Program in Physiological Sciences. For admission and degree requirements, please see Physiological Sciences and Requirements for Doctor's Degrees elsewhere in this catalog. A Master of Science degree is offered only in rare instances when individuals qualified to study for the Ph.D. are forced to terminate their graduate education.

Current research areas of the faculty in the Department of Physiology include: cellular physiology and transport; circulation and respiration, including microcirculation; comparative physiology; endocrinology; gastrointestinal physiology; mathematical physiology; muscle physiology; neural mechanisms, including motor control; regulation of bone formation; renal mechanisms; and reproductive and developmental mechanisms.

The specialized nature of the material and equipment required for courses given in the College of Medicine may necessitate some limitation of enrollment. Medical students will receive preference in courses required for the M.D. degree. All other students must obtain the permission of the instructor before enrolling. Graduate students already enrolled in the College of Medicine departments will be given preference.

In addition to the courses listed below, the Department of Physiology offers temporary courses in the following areas, subject to faculty availability and student interest: neurophysiology, renal physiology, physiology of muscle, molecular and cellular endocrinology, peripheral vascular physiology, respiratory physiology, gastrointestinal and developmental physiology, membrane transport processes in physiology, and cardiac physiology.

503. Cellular Physiology (4) I Fundamental responses of living organisms to environmental changes, by examining mechanisms which operate at the cellular level. Topics include organelle structure and function, transmembrane homeostasis and transport phenomena, excitability, intercellular and intracellular communication, cellular mobility, and nerve-muscle-synapse function. P, CHEM 103b, 104b, 241b, 243b; PHYS 102b; MATH 125a-125b; BIOC 460.

566. * Physiology Laboratory (3) II (Identical with ECOL 566)

568. * Comparative Physiology (3) II (Identical with ECOL 568)

580. * Human Physiology (4) II Principles of physiology with emphasis on the human; designed primarily for students in pharmacy and health related sciences. Consult department before enrolling. P, CHEM 243b, MATH 123, PHYS 102b, CR, 581. (Identical with TOX 580)

581. * Physiology Laboratory (1) I Experiments intended to reinforce principles of physiological phenomena; designed primarily for students in pharmacy and health related sciences. Consult department before enrolling. P, CHEM 243b, MATH 123, PHYS 102b, CR, 581. (Identical with TOX 581)

582. Topics in Neural Development (2) II (Identical with NRSC 582)

585. Neural Mechanisms of Behavior (2) II 1994-95 (Identical with NRSC 585)

588. Principles of Cellular and Molecular Neurobiology (4) I (Identical with NRSC 588)

589. Principles of Systems Neurobiology (4) II (Identical with NRSC 589)

595. Colloquium

a. ** Mathematical Techniques in Physiology (2) [Rpt./12 units] I II P, MATH 125a-125b, 160.
b. ** Muscle Physiology (2) [Rpt./12 units] I II P, 503.
c. ** Endocrinology (2) [Rpt./12 units] I II P, 503.
d. ** Renal Physiology (2) [Rpt./12 units] I II P, 601/801.
e. ** Molecular and Cellular Excitability (2) [Rpt./12 units] I II P, 601/801.
f. ** Peripheral Vascular Physiology (2) [Rpt./12 units] I II P, 601/801.
g. ** Membranes and Transport (2) [Rpt./12 units] I II
h. ** Systems Neurophysiology (2) [Rpt./12 units] I II
i. ** Introduction to Personal Computers in Physiology (2) [Rpt./12 units] I II

** Available as both 595 and 895.

* May be convened with 400-level course.

601. Systems Physiology (7) II Comprehensive coverage of systemic physiology with emphasis on the underlying principles of function. Permission required to enroll; consult instructor before registering.

605. Human Neuroscience (6) I II (Identical with ANAT 605)

610. Research Methods in Physiology (1-3) [Rpt./10 units] I II Laboratory course providing students with an understanding of the types of research available in the department. (Maximum length is 8 weeks). Consult with department before enrolling.

612. Biological Electron Microscopy (4) (Identical with MCB 612)

695. Colloquium

a. Motor Control (2) [Rpt./8 units] II (Identical with EXSS 695a)

696. Seminar

a. Physiology Series (1) [Rpt./3] I II Open to majors only.
b. Physiology: Preparation and Presentation (1) [Rpt./1] II Open to majors only. Consult with department before enrolling.
c. Physiology Student Forum (1) [Rpt./3 units] II

697. Workshop


801. Human Physiology (7) II Comprehensive approach to understanding the system of human physiology

805. Human Neuroscience (6) I II (Identical with ANAT 805)

891. Preceptorship

a. Physiology (3-12) [Rpt./12 units]

895. Colloquium

a. ** Mathematical Techniques in Physiology (2) [Rpt./12 units] I II P, MATH 125a-125b, 160.
b. ** Muscle Physiology (2) [Rpt./12 units] I II P, 503.
c. ** Endocrinology (2) [Rpt./12 units] I II P, 503.
d. ** Renal Physiology (2) [Rpt./12 units] I II P, 601/801.
e. ** Molecular and Cellular Excitability (2) [Rpt./12 units] I II P, 601/801.
f. ** Peripheral Vascular Physiology (2) [Rpt./12 units] I II P, 601/801.
g. ** Membranes and Transport (2) [Rpt./12 units] I II
h. ** Systems Neurophysiology (2) [Rpt./12 units] I II
i. ** Introduction to Personal Computers in Physiology (2) [Rpt./12 units] I II

** Available as both 595 and 895.

Planetary Sciences (PTYS)
Space Sciences Building, Room 325
(602) 621-6963


Associate Professors Willy Benz, Jonathan I. Lunine, Carolyn Porco, Robert B. Singer

Assistant Professors Timothy D. Swindle...
The department offers multidisciplinary programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in planetary sciences. Areas of specialization include, but are not restricted to, experimental, observational, and theoretical study of planetary atmospheres; the interiors of the planets and planetary satellites; asteroid and cometary astronomy and physics; meteoritics, problems of plasma physics associated with cosmic rays; the solar wind and its interaction with solar system bodies; celestial dynamics; investigations of the formation of the solar system and other planetary systems. Students are normally admitted to the doctoral program only. In certain circumstances, however, students may be admitted to the Master of Science degree program as a terminal or intermediate degree.

Applicants should have completed an undergraduate major in a physical science such as astronomy, atmospheric sciences, chemistry, geology, mathematics, or physics. However, admission is based on the overall demonstrated capability and preparation of the applicant. For full consideration, applicants must submit applications, including scores on the aptitude and advanced (chemistry, geology, or physics) tests of the Graduate Record Examination, as well as the names of at least three references. Personal or telephone interviews are desirable in aiding the deliberations of the admissions committee.

Degrees

Master of Science: This program is available only in special circumstances, with the concurrence of the faculty. At least 18 units drawn from the graduate core curriculum and a thesis suitable for publication are required.

Doctor of Philosophy: All students must complete the 15-unit core program consisting of 505a-505b-505c, 510, and 554 (though exceptionally well-prepared students may have parts of this requirement waived). An additional minimum of 21 units must be completed in a specialized area of planetary sciences. A specified reading competence in a modern foreign language is required. Students are expected to complete all requirements for the degree within three or four years following successful completion of the preliminary examination, which itself should be taken by the end of the second year of graduate enrollment.

Minor areas of study: The department requires its students to take a minor consisting of at least 12 units in a scientific area relevant to planetary science. The purpose of the minor is to deepen a student's knowledge of a subject that will support his or her research in planetary sciences. There are two ways of fulfilling this requirement:

- Minor outside the planetary sciences department: The student may elect to minor in another department or approved program of the University. The choice of the department and the courses within that department must be made in consultation with the student's advisor, the minor department, and the Graduate Student Affairs Committee. The student is responsible for determining and fulfilling the current requirements of the minor department.

- Minor in planetary sciences: The student may elect to minor in planetary sciences with a program of courses approved by the planetary sciences department. The minor will consist of at least 12 units of 500-level courses in which a grade of 3.0 (B) or better is achieved. The courses must be approved by a minor committee established by the student in consultation with the Graduate Student Affairs Committee, which will also designate a chairman. The student must pass a written preliminary examination consisting of the final exams or the equivalent in the individual courses. If the student already possesses a master's degree in a relevant scientific discipline, the course requirement may be waived by petition and approval of the entire faculty. In this case the Graduate Student Affairs Committee will designate appropriate members of the University faculty to draw up and administer a two to three hour written examination. The Graduate Student Affairs Committee will advise the student and the appropriate members of the University faculty on whether the student has performed satisfactorily in these examinations.

The planetary sciences minor option: Graduate students from other departments in the University may obtain credit for a minor in planetary sciences by achieving an average grade of 3.0 (B) or better in a minimum of 12 units of 500-level planetary sciences courses (up to 3 of which may be independent study supervised by a planetary sciences faculty member). The proposed curriculum of each student must be approved by a minor committee established by the student in consultation with the LPL Graduate Student Affairs Committee, which will also designate a chairman. The written preliminary examination will consist of the final exam or the equivalent in the individual courses.

The Department of Planetary Sciences' degree programs are conducted in collaboration with the research programs of the Lunar and Planetary Laboratory (LPL). Together, the department and laboratory form an institute uncommonly broad and complete in its approach to planetary science education and research. The department and laboratory participate in many NASA science missions. Among the current missions in which the faculty are participating are the Voyager Mission, the Magellan Mission to Venus, the Galileo Mission to Jupiter, the Cassini/Huygens Mission to Saturn, the Comet Rendezvous Asteroid Flyby Mission, and the Ulysses Heliospheric Probe. In addition, LPL scientists make use of Earth orbiting observatories, including the Hubble Space Telescope and the Ultraviolet Explorer. The laboratory's Space Imagery Center contains one of the most extensive collections of planetary images in the world, beginning with those obtained from the earliest space projects and continuing to most current missions. LPL's Planetary Imaging Research Laboratory is a modern image processing facility for the analysis of planetary and astronomical data. Also available for student research are cosmochemistry and geochemistry laboratories, including a scanning electron microscope and microprobe facility, an experimental petrology laboratory, a radiochemistry separation and neutron activation laboratory, and a noble gas mass spectrometry laboratory. The numerous telescopes of the University of Arizona Observatories are available for research projects, including instruments on Kitt Peak and in the Santa Catalina Mountains, as well as the Multiple Mirror Telescope on Mt. Hopkins; all are within easy reach of the University campus. Laboratory staff and students can also make use of major observatories around the world, including the NASA Infrared Telescope Facility on Mauna Kea, Hawaii, and conduct a regular program of planetary, solar, and stellar infrared spectroscopy using the NASA Kuiper Airborne Observatory. The University is developing a new observatory site on Mr. Graham, northeast of Tucson. The department participates in interdepartmental programs in theoretical astrophysics and in applied mathematics.

The University's computer center, including a Convex supercomputer, is...
available to support educational and research activities. The Lunar and Planetary Laboratory maintains a variety of networked computers and workstations in support of the research and educational programs.

503. *Introduction to the Solar System* (3) 1993-94 Survey of planetary physics, planetary motions, planetary interiors, geophysics, planetary atmospheres, asteroids, comets, origin of the solar system. This course does not count toward the major requirements in planetary sciences. P, PHYS 112a or PHYS 121. (Identical with ASTR 503 and GEOS 503)

505a-505b-505c. Principles of Planetary Physics (3-3-3) Planetary and interplanetary fluids and plasmas, structure and behavior of planetary matter, and transport processes. Applications of geophysics, fluid mechanics, and statistical physics to planetary interiors, surfaces, and atmospheres; rheology of planets, atomic and molecular spectroscopy, radiative transfer, Principles of celestial mechanics. P, PHYS 435.

510. Principles of Cosmochemistry (3) I 1994-95 Chemical compositions of solar system objects; equilibrium and nonequilibrium chemical processes applied to planets; cosmochronology. (Identical with GEOS 510)


519. *Modern Tectonic Processes* (3) II (Identical with GEOS 519)

520. Meteorites (3) II 1994-95 Classification; chemical, mineralogical and isotopic composition; cosmic abundances; ages; interaction with solar and cosmic radiation; relation to comets and asteroids. P, 510. (Identical with GEOS 520)


530. Chemical Evolution of the Earth (3) I (Identical with GEOS 530)

541a-541b. *Dynamic Meteorology* (3-3) (Identical with ATM 541a-541b)

544. Physics of High Atmospheres (3) I 1994-95 Physical properties of upper atmospheres, including gaseous composition, temperature and density, ozonosphere, and ionospheres, with emphasis on chemical transformations and eddy transport. (Identical with ATM 544)

545. Stellar Atmospheres (3) I 1994-95 (Identical with ASTR 545)


554. Evolution of Planetary Surfaces (3) II 1994-95 The geologic processes and evolution of terrestrial planet and satellite surfaces including the Galilean and Saturnian and Uranian satellites. Course includes one or two field trips to Meteor Crater or other locales. (Identical with GEOS 554)

555. Remote Sensing of Planetary Surfaces (3) II 1993-94 Exploration of planetary surfaces, including that of the Earth, with remote sensing. Emphasis on compositional determination using visible and infrared methods. Basic principles, image and spectrophotometric analysis techniques, and case studies in planetary remote sensing. (Identical with ASTR 555 and GEOS 555)


567. Inverse Problems in Geophysics (3) I 1994-95 (Identical with GEOS 567)

571. Terrestrial Planets (3) I 1994-95 Geophysical and geochronological techniques used to deduce composition and evolution of terrestrial planets. Topics include the Earth, Moon, Mars, Venus, and meteorites. (Identical with GEOS 571)

582. High Energy Astrophysics (3) II 1993-94 (Identical with ASTR 582)

583. Thermodynamics in Geosciences (3) I (Identical with GEOS 583)

589. Topics in Theoretical Astrophysics (3) [Rpt.] I (Identical with PHYS 589)


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Planning (PLNG)

Graduate Interdisciplinary Program in Planning

Committee:
Professors Kenneth N. Clark, Chair (Architecture), Robert B. Bechtel (Psychology), Michael Bonine (Geography), Nathan Buras (Hydrology and Water Resources), Hanna J. Cortner (Renewable Natural Resources), Kenneth E. Foster (Arid Lands), Lay J. Gibson (Geography), Robert C. Gieber (Architecture), R. Frank Gregg (Emeritus), William Havens (Landscape Architecture), Robert Hershberger (Architecture), Helen M. Ingram (Political Science), David A. King (Renewable Natural Resources), W. Kirby Lockard (Emeritus), Lawrence D. Mann (Geography), Fred S. Matter (Architecture), Gordon F. Mulligan (Geography), Phil R. Ogden (Range Management), Richard W. Reeves (Geography), Sandra Rosenbloom (Architecture), Thomas F. Saarinen (Geography), Arthur L. Silvers (Public Administration and Policy), Sorosh Soroshian (Hydrology and Water Resources), Ervin H. Zube (Renewable Natural Resources)

Associate Professors D. Robert Altschul (Geography), Harry Der Boghosian (Architecture), Michael D. Bradley (Hydrology and Water Resources), Nader Y. Chalfoun (Architecture), Dennis C. Doxter (Architecture), H. Randall Gimblett (Landscape Architecture), Charles E. Glass (Mining and Geological Engineering), Alfredo R. Huete (Soil and Water Science), Stuart E. Marsh (Arid Lands Resource Sciences), David A. Plane (Geography), Charles M. Poster (Architecture), Donovan C. Wilkin (Renewable Natural Resources), Robert H. Wortman (Civil Engineering)

Assistant Professor D. Phillip Guertin (Watershed Management)

The interdisciplinary Program in Planning directs a graduate professional program leading to the Master of Science degree with a major in planning.

The major consists of 54 units: 36 units of core course work and 18 units in a chosen area of concentration. Core courses include 500, 544, 557, 584, 602, 605, 609, 611, 657, 693, 696, and 700. Areas of concentration include: arid lands (addressing development in arid environments), community design (focusing on physical dimensions of urban design), environmental planning (addressing behavioral aspects of environmental issues), regional planning (emphasizing mainstream urban and regional land-use development), renewable natural resources (allowing both resource management and landscape design options), transportation planning (addressing travel forecasting and facilities design), and water resources (allowing both analytical and policy options).

The program requires completion of a projects course. A comprehensive written examination or professional report must be completed as part of the 54 units of course work. Internship experi-
ence is required and students are exposed to field applications in other course work as well. The program is specifically designed to expose students to the interdisciplinary nature of most planning problems. The course work provides a mixture of theoretical and practical perspectives on diverse planning issues.

Interested persons should contact the program chair for further information.

500. Ecosystemology for Urban Planning (3) (Identical with HWR 500)
504. Policy Problems in Structure and Change (3) II (Identical with PA 504)
510. Development of Regional Planning (3) (Identical with GEOG 510)
514. Analytic Methods in Planning and Management (3) II (Identical with PA 514)
523. Health and Public Policy (3) II (Identical with PA 523)
527. Aging and Public Policy (3) I (Identical with PA 527)
544. Site Planning (3) II (Identical with ARCH 544)
550. Metropolitan and Regional Planning (3) I (Identical with GEOG 550)
553. Location Analysis (3) I (Identical with GEOG 553)
556. Urban Systems Analysis (3) II (Identical with GEOG 556)
557. Statistical Techniques in Geography, Regional Development and Planning (3) I (Identical with GEOG 557)
559. Land Use and Growth Controls (3) II (Identical with GEOG 559)
560. Resource Management (3) II (Identical with GEOG 561)
563. Perception of Environment (3) I II (Identical with GEOG 563)
565. Project Planning and Modeling (3) II (Identical with CE 565)
567. Geographical Analysis of Population (3) I (Identical with GEOG 567)
568. Urban Transportation Planning (3) II (Identical with CE 568)
571. Problems in Regional Development (3) I II (Identical with GEOG 571)
573. Geology and the Urban Environment (3) II (Identical with GEOG 573)
576. The Land Development Process (3) [Rpt./I] I II S (Identical with GEOG 576)
581. Computer Cartography (3) II (Identical with GEOG 581)
583. Geographic Applications of Remote Sensing (3) II (Identical with GEOG 583)
584. Planning the Built Environment (2) (Identical with ARCH 584)
593. Internship
   g. Policy and Planning (1-4) S (Identical with PA 593g; which is home)

596. Seminar
   u. Interdisciplinary Environment-Behavior-Design (3) II (Identical with ENV 596u; which is home)
597. Workshop
   a. Architecture (3-8) [Rpt.] I II (Identical with ARCH 597a; which is home)
   b. Community Design for Non-Designers (3) I (Identical with ARCH 597i; which is home)
   c. Community Design for Non-Designers (3) II (Identical with ARCH 597i; which is home)

*May be convened with 400-level course.
605. Planning Theories and Perspectives (3) I (Identical with GEOG 605)
611. Projects in Regional Planning (1-5) [Rpt./S units] II (Identical with GEOG 611)
657. Spatial Analysis (3) II (Identical with GEOG 657)
665. Quick Response Transportation Planning Methods (3) I 1993-94 (Identical with CE 665)
668. Urban Public Transportation Systems (3) I 1994-95 (Identical with CE 668)
669. Preservation of Historic Environments (3) II 1993-94 Current planning and legal methods to enhance the preservation of historic urban areas and structures; concentrated analysis of selected case studies. Field trips.
669. Seminar
   b. Financing Public Services (3) I (Identical with ARCH 669b; which is home)
   c. Land-Use Regulation (3) I II (Identical with ARCH 669c; which is home)
   d. Legal Inquiry in Policy and Planning (3) II (Identical with ARCH 669d; which is home)
   e. Environmental Planning (3) I II (Identical with ARCH 669e; which is home)
   f. Planning Administration (3) I II (Identical with ARCH 669f; which is home)

Plant Pathology (PLP)

Forbes Building, Room 104
(602) 621-1828

Professors Merritt R. Nelson, Head, Stanley Alcorn (Emeritus), Robert L. Gilbertson, Richard B. Hine, Michael A. McClure, Michael E. Stanghellini, Hans D. Van Etten

Associate Professors H. Earl Bloss (Emeritus), Martha C. Haynes, Christina K. Kennedy, Iraj J. Misaghii

Assistant Professors Marc Orbach, Leonard S. Pierson III, Zhongguo Xiong

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in plant pathology. Subject area specialties within the department include mycology, nematology, virology, and microbiology. Research programs within these specialties emphasize basic and applied research in the areas of plant-microbe interactions and include pathogenic, symbiotic, and beneficial interactions. These research programs include studies at both the molecular and organismal level and a number of programs emphasize rhizosphere interactions.

Applicants to the department should have a bachelor's degree and a solid background in biology, biochemistry, botany, or microbiology and must submit scores on the tests of the Graduate Record Examination to the department. Additional information and requirements for the graduate program can be obtained by directly contacting the department.

At least twenty-two units in coursework must be completed for the master's degree. A decision to require or waive the requirement for a master's degree thesis will be made after consideration of the student's preparation, proposed graduate program, and professional objectives.

For information concerning the Doctor of Philosophy degree see Requirements for Doctors' Degrees/Doctor of Philosophy elsewhere in this catalog.

502. Agriculture and the Environment: Focus on Pesticides (3) I (Identical with AE 502)


550. Advanced Plant Pathology (4) I 1994-95 Topics include major concepts in classical and molecular genetics of plant-pathogen interactions; physiology, biochemistry, and molecular biology of plant pathogenesis; principles of plant epidemiology and theories and practices of plant disease control. P, 502 or equivalent.

551. Biology and Characterization of Plant Pathogenic Agents (4) II 1994-95 Examines the biological properties of the various groups of plant pathogens and the contemporary laboratory methods used to characterize these agents and the diseases they cause. 3R, 3L, P, 505 and at least one laboratory course (e.g., MIC 205, MCB 181/182, etc.) or consent of instructor.

575. Advanced Mycology (3) I 1993-94 Biology of fungi, including morphology, physiology, classification, genetics, ecological significance, and economic importance; emphasis on plant pathogens and environmentally essential fungi. 2R, 3L, P, ECOL 104 or PL S 100.

596. Seminar
   a. Current Research (1-3) [Rpt./8] I II

*May be convened with 400-level course.


602. Signal Exchange in Plant Root-Microbe Interactions (3) II 1993-94 Examination of the-
Current advances in the structure of viral genomes, function and regulation of viral genes, molecular plant-virus interactions, and molecular strategies for viral disease control. The ready availability of modern laboratories, field space, and greenhouses within the department insures that students have access to the very best facilities.

During their tenure all graduate students will take a core of advanced courses including plant physiology, genetics, and anatomy and are expected to participate in departmental teaching and seminar programs. The needs and goals of individual students will determine subsequent course work from the various departments on campus. For their own research programs, students should select an area of specific interest to the faculty which will eventually lead to the preparation of a thesis. Where appropriate, a terminal M.S. program without the requirement for thesis research but emphasizing a broader selection of course work in plant sciences and related areas is available. Admission to doctoral studies without prior completion of the M.S. degree will also be considered on an individual basis for interested candidates.

Applicants are expected to have completed a bachelor's degree and possess a good background in biology, chemistry, and mathematics. Under exceptional circumstances, candidates with specific deficiencies will be accepted into the program and required to remedy deficiencies early in their graduate studies. Applicants must submit scores from the Graduate Record Examination (GRE) for both the General Test and one advanced test in an appropriately related area. They should also arrange to have three letters of recommendation from individuals in a position to assess their potential as a graduate student sent to the department. Requests for information on additional requirements or further questions concerning the application process should be addressed to the Graduate Student Coordinator, Department of Plant Sciences. Individuals wishing to start in the fall semester are strongly encouraged to apply prior to January 1, particularly if they desire financial assistance.

505.* Weed Science (3) I Principles and effects of controlling agronomic and horticultural weeds, with emphasis on chemical control methods; weed identification. 2R, 3L. P, ECOL 260, ECOL 302, CHEM 241, SW 200.

508.* Arid Land Crop Ecology (3) II Physical and biotic environment of crops in relation to crop culture, production, and geographical distribution; relations among the human population, crop productivity, and man's environment. P, ECOL 260, MCB 181, MCB 182.

509. Information Sources for Agricultural Scientists (1) I Information systems and retrieval techniques, with particular reference to concepts, uses and limitations; emphasis on abstracts, indexes, alerting services, journals and government documents. (Identical with LI S 509)


515.* Principles of Plant Breeding (3) I Application of the principles of genetics, botany and statistics to the improvement of plants. P, 312 or ECOL 320.

530.* Plant Propogation II: Plant Cell and Tissue Culture (3) II Principles and theory of plant tissue culture. Commercial and experimental applications of micropropogation, plant cell/protoplast culture, and plant transformation techniques. 2R, 3L. P, PL S 312 or MCB 181, PL S 330 or consult of instructor.

541. Economic Botany of Arid Lands (3) I Examines past, present, and potential future industries based on plant resources in arid lands. Survey of useful products from arid lands plants, their biosynthesis and physiological function, taxonomic and geographic sources, and their role in local and global economies. P, 460. (Identical with AR L 541)

550.* Developmental Plant Anatomy (4) I Structure, function and development of vascular plants. 3R, 3L. P, 100 or MCB 181.

560.* Plant Physiology (4) I Introduction to water relations, photosynthesis, respiration, growth and development of higher plants. 3R, 3L. P, 100 or MCB 181, CHEM 241a, 243a.


563.* Plant-Water Relations (3) II Analytic approach to the study of water movement into and through plants; development of internal water deficits and their significance to physiological processes. P, 460 or ECOL 260. (Identical with WS M 563)

564. Plant Growth and Development (3) II 1993-94 Selected topics in growth and development. P, 460 (Identical with MCB 564)

575.* Physiology of Crop Production (3) II Plant processes, modifications, and environmental interactions in relation to growth of crop plants, with emphasis on recent advances and research techniques. P, 460.
plan to continue into a Ph.D. program. In addition, the department also designs programs for students interested in government careers, community college teaching, or specialization in selected areas such as policy and environment or for self-improvement. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Applicants must submit scores on the Graduate Record Examination, two letters of recommendation, and the personal data called for on the department's information form. Applicants are also invited to submit any other evidence, including published materials, which they believe to be relevant to admission.

Programs are planned, in consultation with an advisory committee, around the student's principal area of interest, emphasizing one or more of the areas of concentration listed above.

**Degrees**

**Master of Arts:** Each student must specialize in either one or two of the six fields of concentration listed above and complete at least 30 units of course work with at least 24 units at the 500 and 600 levels. A supervised research paper is required and, depending upon the student's principal interest, reading knowledge of a foreign language may be required. The final master's examination will be based upon the chosen area or areas of concentration.

**Doctor of Philosophy:** In addition to an area of concentration, each student must prepare in two additional fields prior to the preliminary examination. Either two foreign languages or one foreign language at high proficiency or advanced training in methodology are required. Finally, each student must complete two supervised original research papers prior to taking the preliminary examination. The department may waive the requirement for a qualifying examination for a student who has received the master's degree at the University of Arizona.

**Politics and Administration**


506. *Bureaucracy, Politics, and Policy* (3) I Description and analysis of the executive branch of government: how federal agencies capture policy-making; why bureaucracy develops; the rules of bureaucratic culture; who controls the administrative branch.

507. *Congress and American Politics* (3)  I  II Examination of election politics, personalities, and career patterns of congressional members, the organization and structure at Congress, and the role of Congress in policy leadership and representation of the public. P, 102.

510. *Struggle for the Presidency* (3) I (Identical with COMM 510)


521. *Ancient and Medieval Political Theory* (3) I Development of Western political theory from the Greeks to Machiavelli. P, 102; or PHIL 110, 113, or 121.

522. *Early Modern Political Theory* (3) II Western political theory from Machiavelli to Marx. P, 102, 160 or PHIL 110, 113, or 121.

523. *Recent Political Thought* (3) I Political theory from Marx to the present. P, 102, 160 or PHIL 110, 113, or 121.

526. *Cross-National Research Methods* (3) I (Identical with SOC 526)

527. *Marxism and its Critics* (3) II A critical survey of the main currents of Marxism from Marx to the present.

531. *Political Culture and the Dynamics of Change in American Society* (3) I Examination of the manner in which attitudes about politics and political problems are acquired from exposure to music and television, and the manner in which such attitudes lead to political action. P, 102.

532. *Pressure Groups* (3) I Formation, structure, and place of pressure groups in the democratic society; the function of interest groups in the political process; problems of leadership, internal organization, and membership loyalties. P, 102.


536. *Political Socialization* (3) II Description and analysis of how and why people feel, and respond to, authority. Based on the assumption that people's reactions to the public order are influenced by the private order—or disorder—of their minds and the way they were socialized, this course builds on the relationship between attitudes, opinion, and voting behavior in American politics. P, 102.

537. *Democracies, Emerging and Evolving* (3) I Causal analysis of conditions of stability and breakdown of democratic regimes with particular emphasis on the developing democracies of the third world. P, 102. (Identical with LA 537)

538a-538b. *Philosophy of Law* (3-3) (Identical with PHIL 538a-538b)

541. *Arab-Israeli Conflict* (3) I II Traces the birth and growth of the Arab-Israeli conflict since 1948 with particular attention to the internal impediments to conflict resolution on both the Arab and Israeli sides. Also surveys
the role of the Great Powers in Middle East politics generally. P, 102.

542. *Transformation of Agrarian Societies in the Middle East (3) II (Identical with NES 542)

543. *Soviet Politics (3) I Revolution and contemporary ideology; state, party, and mass organizations; economic and social planning; civil liberties; models of autocracy and pluralism. P, 102.

544. *East European Politics (3) III Divergent models of Communist development, from East Germany to Yugoslavia; political, economic, social, and cultural reform. P, 102.

545. *Comparative Political Revolution (3) I Examination of the causes and consequences of 20th-century revolutions and the revolutionary process, with emphasis on contemporary events.

547. *Latin-American Political Development (3) III Presentation of strategies for development in Latin America; examination of case studies from Cuba, Brazil, Chile, Guatemala, and other countries. P, 102. (Identical with LA S 547)

548. *Government and Politics of Mexico (3) I Description and analysis of Mexico's political economy; its political system, and its foreign policy, with emphasis on Mexican-U.S. relations. P, 102. (Identical with LA S 548)

549. *The Politics of Cultural Conflict (3) I Comparative examination of the approaches of different types of political systems to domestic conflict of a racial, religious, linguistic, and/or ethnic nature. P, 102.


551. *Soviet Foreign Policy (3) I Ends and means of Soviet foreign policy; the decision-making process; Soviet relations with the West and developing nations. P, 102.

552. *Communist Foreign Relations (3) II Interrelations of fourteen Communist-party states, with emphasis on cooperation and conflict in such organizations as the Cominform and the Warsaw Pact. P, 102.

553. *Revolution, Insurgencies, and Guerrilla Movements (3) II Exploration of the sociopolitical and economic origins of revolutionary and guerrilla movements, the strategies adopted by insurgent groups, and guerrilla tactics. Open to juniors and seniors only. P, 458/558.

554. *Theories of International Relations (3) I Introduction to theories of international relations on the levels of man, the nation-state, and the international system, with a logical and empirical evaluation of approaches and theories. P, 102, 120 or 250, 247.

555. *American Foreign Policy (3) I Analysis of the Cold War; Congressional-Executive clashes over foreign policy control; approaches to policy analysis. P, 102.

556. *International Law (3) I The international state system; legal-political problems, including territory, environment, seas. P, 102, 120, or 250.

557. *Inter-American Politics (3) I Survey and analysis of the leading political and economic issues at controversy between the United States and Latin America. P, 102. (Identical with LA S 557)

558. *Civil-Military Relations in the Third World (3) I II For description of course topics, see 458. Graduate-level requirements include an extensive research paper.

560. *Modern Chinese Foreign Relations (3) II Survey of the developments and trends in Chinese foreign relations in the modern period, focusing mainly on the relationship between the theoretical and actual objectives of China's foreign policies from 1949 to the present. (Identical with CHN 560)

561. *Feminist and IR Theories (3) II Issues in epistemology; survey and integration of feminist and IR theories; application of feminist theories to IR. P, WS 100 and POL 120 and 250.

564. *International Relations of East Asia (3) II National interests, issues and conflicts, relations, and influence of domestic politics in interstate relations in East Asia. P, 102. (Identical with EAS 564)

567. *Population and Development in the Middle East (3) I (Identical with NES 567)


571. *Constitutional Law: Civil Liberties (3) I II Analysis of the constitutional guarantees of civil liberties in the U.S. P, 102.

574. *Administrative Law (3) I Law governing the organization, powers, and procedures of the executive and administrative establishment, with emphasis on the limitations imposed by the American constitutional system. P, 102.


578. *American Indians and the Supreme Court (3) I II S Examination of the U.S. Supreme Court as a policy-making institution; with analysis of major court opinions affecting tribal sovereignty and individual Indian rights in such areas as tribal status and federal relations, treaty law, Indian land title, jurisdiction. P, 334 (Identical with AINS 578)

579. Research Design (4) I Introduction to experimental and quasi-experimental research design; survey research; the use of aggregate statistics; historical documents and life-history materials; participant observation; unobtrusive methods.

580. Methods of Political Inquiry (3) I Systematic examination of problems of scope and methods of inquiry in the discipline of political science; intended to acquaint students with the discipline and to prepare them for scholarly research in the field.

581. *Environmental Policy (3) II Role of government in management of energy, natural resources and environment; process and policy alternatives; special attention to the Southwest. P, 102. (Identical with HWR 581 and RNR 581)

582. Research and Methodology (4) I II Quantitative techniques and computer applications in political science.


584a-584b. Development of Federal Indian Policy (3-3) 584a: European colonial precedents through the treaty-making period. P, 334. 584b: End of treaty-making to the present. P, 334. 584a is not prerequisite to 584b. (Identical with AINS 584a-584b)

585. Political Risk and Intelligence Analysis (3) I II Examination of political risk and intelligence analysis with emphasis on forecasting political developments in nations.

586. *Political Systems of India and Pakistan (3) II (Identical with NES 586)


589. *Public Choice (3) I II (Identical with ECON 589)

595. Colloquium
a. American Political Institutions (3) I II
b. Survey of Political Theory (3) I II
c. Comparative Politics (3) I II
d. International Relations (3) I II
e. Public Policy (3) I II (Identical with ECON 589)

596. Seminar
a. American Political Institutions (3) [Rpt. 2] I II
b. Political Behavior (3) [Rpt. 2] I II
c. Political Theory (3) [Rpt. 2] I II
d. Comparative Politics (3) [Rpt. 2] I II (Identical with LA S 596d)
e. International Relations (3) [Rpt. 2] I II (Identical with LA S 596d)
f. Public Policy (3) [Rpt. 2] I II (Identical with PA 596g)
h. American Indian Law and Policy (3) [Rpt. 2] I II (Identical with AINS 596h)
i. Management and Policy for Ecological Sustainability (3) [Rpt. 2] I II (Identical with RNR 596d and PA 596i)

596i. Seminar
i. International Water Resource Management (1-3) [Rpt. 2] I II (Identical with HWR 696i, which is home)
j. Public Choice I (3) I II (Identical with ECON 696w, which is home)
k. Political Science (3) I II (Identical with ECON 696w, which is home)

Portuguese

(See Spanish and Portuguese)
Psychology (PSYC)

Psychology Building, Room 312  (602) 621-7447

Professors Lynn Nadel, Head, Carol Barnes, Neil R. Bartlett (Emeritus), Lee Roy Beach (Management and Policy), Robert B. Bechtel, Judith Becker (Psychiatry), Allan Beigel (Psychiatry), Richard Bootzin, Dipanark Chakravarti (Marketing), William D. Crano (Communication), Terry C. Daniel, George Domino, Kenneth Forster (Cognitive Science), Merrill Garrett (Cognitive Science), Michael Gottfredson (Management and Policy), Barbara Gutek (Management and Policy), Travis Hirschi (Sociology), Sigmund Hsiao, William H. Ittelson, Marvin W. Kahn, Alfred Kasznia, John F. Kihlstrom, James E. King, Mary P. Koss (Family and Community Medicine), Robert W. Lansing, Bruce McNaughton, Amnon Rapoport (Management and Policy), Carl A. Ridley (Family and Consumer Resources), David Rowe (Family and Consumer Resources), Bruce D. Sales, Jose Santiago (Psychiatry), Gary Schwartz, Lee Sechrest, Mary C. Wetzel, David B. Wexler (Law), Robert L. Wrenn
Associate Professors Harold S. Arkowitz, Merrie L. Brucks (Marketing), Lawton R. Burns (Management and Policy), Jeff Greenberg, Richard Lane (Psychiatry), Irene M. Pepperberg (Ecology and Evolutionary Biology), Mary Peterson, Ronald H. Pool, Christopher Puto (Marketing), Rosemary A. Rosser, Catherine Shisslak (Family and Community Medicine), Varda Shoham, Linda Swisher (Speech and Hearing Sciences), Gary Wenk

Assistant Professors Geoffrey Ahern (Neurology), John Allen, Felice Bedford, Iris Belle (Psychiatry), Paul Bloom, Aurelio J. Figueredo, Daniel J. Flannery (Family and Consumer Resources), Elizabeth Glisky, Kelly Green, Elizabeth Krupinski (Radiology), Akiva Liberman, Chad Marssolek, Laura McCloskey, Mark Mennemeier (Psychiatry, Neurology), Janet Nicol (Linguistics), Tamra Pearson-D’Estree, Cyma Van Petten, Karen Wynn

The department offers programs designed for students seeking completion of the Doctor of Philosophy degree with a major in psychology. Concentrations are available in clinical psychology (clinical neuropsychology, psychopathology and affective disorders, health psychology and community and family mental health), cognitive psychology (perception, memory, psycholinguistics, cognitive neuropsychology, cognitive development, environmental cognition, and knowledge representation), developmental psychology (cognitive development, language development, and social and emotional development), psychology (animal behavior, neurobiology of learning, memory and aging, cognitive and computational neuroscience, neurophysiology, and psychopharmacology), and psychology, policy and law (mental health and health policy, mental health and criminal justice interactions, analysis of policies and laws). A social psychology program is under development. In addition, there are two areas of concentration in which students may minor: environmental psychology, and measurement and field research.

Applicants should contact the department early to obtain departmental application materials since the deadline for receipt of completed materials is February 1. Applicants must submit scores on the aptitude and advanced (psychology) tests of the Graduate Record Examination. Psychology, policy, and law concentration applicants interested in concurrently pursuing the J.D. degree must apply separately to the College of Law.

503.* Laboratory in Mammalian Systems Neurophysiology (3) II Neurophysiology laboratory including stereotactic surgery, microelectrode recording of neural signals, electrical and chemical stimulation, and principles of analog and digital signal processing.

504. Human Brain-Behavior Relationships (3) I Human brain functions in relation to intelligence, speech, memory, judgment and reasoning, and visual-spatial abilities; methods of examination of human brain function; perceptual development through childhood.

505. Psychological Research (3-3) Statistical research design, methods and meta-science. Both semesters include an introduction to computerized analytical techniques and software commonly applied in psychological research, such as SAS, SPSSX, BMDF, and EQS. 507a: Bivariate and multiple regression, application of structural equations modeling to manifest variable (path analysis) and latent variable (multivariate) causal analysis. 507b: Application of the general linear model to analysis of variance, covariance and multiple comparisons, exploratory and confirmatory factor analysis, the canonical correlation, discriminant function analysis and multivariate analysis of variance. Open to majors only.

508. Methods for Field Research (3) I II Research problems and methods particularly relevant to field research. The logic of inquiry and approaches to data analysis appropriate to field trials and quasi-experimental research.

509. History of Psychological Theories and Research (3) II Development of psychology as a science; schools, systems, theories, major advances, famous investigators. Open to psychology graduate students only.

510. Advanced Social Psychology (3) I II Social psychology, with emphasis on theory and method.


512. Animal Learning (3) II Animal learning with emphasis on interspecies comparisons.

513. Drugs, Brain and Behavior (3) I II Psychopharmacology, neurotoxic and behavioral effects of drugs on individual neurotransmitter systems in the brain. Special emphasis will be given to the historical use and political significance of the major drugs of abuse.

514. Personality and Social Development (3) I II Research and theory in developmental psychology with an emphasis on social cognition, social and emotional growth.

515. Advanced Topics in Cognitive Development (3) I Examination of major theories and research findings in cognitive development, with emphasis on infant cognition and conceptual development through childhood. Topics include concept representation and development, naive theories of the world, and knowledge restructuring.

516. Advanced Personality (3) I II In-depth consideration of topics, issues and research in personality.

519. Field-Based Human Learning (3) I II Learning principles in terms of behavioral ecology. Naturalistic study with video and computer methods of human services and academic settings.

521. Psychology of Death and Loss (3) I II Basic concepts in a psychology of death and loss, with emphasis on both the adjustment to death and loss, and the underlying phenomena, humanistic and current social considerations.

522. Advanced Abnormal Psychology (3) I Survey of the causes and treatments of various forms of behavior disorder; basic concepts and critical evaluation of current research and theories.

525. Thinking, Reasoning, and Problem Solving (3) II Survey of historical and current
theories and research on human thinking, reasoning and problem solving.

527.* Field Methods in Environmental Psychology (3) II Behavior in man-made or managed environments, with emphasis on objective methods; designed for students having a professional interest in environmental design or management. (Identical with ARCH 527 and L AR 527)

528. Cognitive Neuroscience (3) [Rpt./1] II Recent advances in analysis of the neural bases of cognitive functions, such as learning, memory, and thinking.

529.* Advanced Topics in Perception (3) [Rpt./2] II Perception of space, theories of object recognition, evolutionary constraints, learning, attention, visual cognition, and theories of perception.

530. Psychology, Law and Social Policy (3) [Rpt./3] II Critical review of theory, methods, and research in the psychology, law and social policy interface.

531.* Ethical Issues in Psychology (3) I II A consideration of issues in the derivation of ethical criteria, selection of the appropriate subset of criteria to guide ethical decision making, and utilization of the criteria when making a decision in psychological research or practice.

535. Adult Development and Aging (3) I Change and continuity in cognition, personality, and adjustment during adulthood, with emphasis on aging processes and late life. (Identical with GER 535)

537. Gerontology: A Multidisciplinary Perspective (3) II Biological, psychosocial, and social issues in aging, including brain changes with age, cognitive change with age, and the social impact of increasingly older population demographics. (Identical with GER 537 and NRSC 537)

540. Visual Cognition (3) [Rpt./1] II Recent advances in the areas of perception and attention, with an emphasis on visual process.

541. Topics in Language and Cognition (3) [Rpt./1] II Variable content, including language acquisition, the relation between language and spatial cognition, and the evolution of mind. P graduate majors in linguistics and psychology, others consult with department before enrolling.

542. Psycholinguistics (3) [Rpt./1] II Recent advances in the area of psycholinguistics, with an emphasis on sentence processing and the contribution of linguistic theory to an understanding of psychological mechanisms.

546. Environmental Cognition (3) [Rpt./1] II Recent advances in the area of environmental cognition, with an emphasis on cognitive aspects of environmental psychology.

549.* Social Cognition (3) [Rpt./6 units] II Analysis of social phenomena from a cognitive perspective: perception, memory, thought and language concerning self, others, and social situations or permission of instructor.

550. Psychological Assessment and Testing (3) II Evaluation of assessment processes and of measurements of intelligence, aptitude, personality, and interests; test theory; social implications.

553. Lexical and Syntactic Development (3) I II Current and historical data and first language acquisition with special focus on research that relates linguistic theory and learnability theory to empirical studies of children's linguistic abilities. (Identical with LING 553)

554. Culture and Mental Health (3) I Mental health in cross-cultural perspective; universal and culture specific disorders, traditional and western psychotherapy, cultural values in treatment methods and in research. P, 290, 322.

555. Philosophy and Artificial Intelligence (3) [Identical with PHIL 555]

556. Psychopathology (3) II In-depth study of current theoretical and research formulations in psychological disorders; various approaches to behavior change. P, 290, 322.

562. Mental Health Policy (3) [Rpt./3] II Theory, research and practice in law and mental health interactions and in the delivery of mental health services.

564. Methods for Psychosocial Research (3) I Logic of inquiry and issues of philosophy of science as they apply to psychosocial research. Problems encountered by researchers in personality, family studies, social and clinical psychology, and creative approaches to their data analysis and methodological design resolutions.

565. Neural Encoding, Memory and Computation in the Mammalian Brain (3) I II Theoretical principles and biological mechanisms by which information is represented, categorized, stored, and recalled in specific central nervous system (CNS) circuits in the course of adaptive behavior. (Identical with NRSC 565)

566. Principles of Mammalian Systems Neurophysiology (3) I II Topics in the neurophysiology of sensation, perception, cognition and action in mammals illustrating the application of modern research methods to the understanding of higher brain function. Enrollment is restricted to those concurrently enrolled in the lab. (Identical with NRSC 566)

567. Experimental Phonetics: Physiology (3) [Identical with SP H 567]

568. Experimental Phonetics: Acoustics and Perception (3) II (Identical with SP H 568)

572. Human Memory Systems (3) II Examines the processing systems that underlie human learning, memory and cognition; emphasizing cognitive, neuroscience and computational approaches to research and theory.

573. Natural Language Processing (3) II (Identical with LING 573)

575. History of Psychology (3) I Growth of psychology as a science; major schools and theories; contributions of famous investigators and major advances; psychology as an art and a science today.

578. Sleep and Sleep Disorders (3) II Topics include sleepwake rhythms, sleep depriva-
b. Psychotherapy (1-3) [Rpt/1] I II Open to clinical psychology students only.
c. Advanced Psychotherapy (1-3) [Rpt/1] I II Open to clinical psychology students only.

695. Colloquium
a. Motor Control (2) II (Identical with EXSS 695a)

696. Seminar
f. Linguistic Investigations and Applications (3) I II (Identical with LING 696h, which is home)

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Public Administration and Policy (PA)

McClelland Hall, Room 405
(602) 621-7965

Professors Michael Gottfredson (Management and Policy), Helen Ingram (Political Science), Theodore Koff, John Schwarz (Political Science), Arthur Silvers
Associate Professors H. Brinton Milward, Director, Lawton R. Burns (Management and Policy), Ronald Vogel
Assistant Professors Susan Gonzalez Baker (Mexican American Studies), Chris Demchak, Howard Frant, Michael Polakowski, Edella Schlager

The School of Public Administration and Policy offers the Master of Public Administration, which is designed to prepare men and women for positions of leadership in public sector and nonprofit organizations, as well as private organizations dealing with the public sector. Graduates may expect to pursue management or policy-making concerns in a wide variety of settings within organizations at local, state, national, and international levels.

For admission and degree requirements, please see Master of Public Administration elsewhere in this catalog.

501. Public Organization Theory (3) I II Course focuses on understanding and analyzing interactions, effectiveness of organizations.

503. Politics and the Policy Process (3) I II Various theories of how public policy is formulated.

504. Public and Policy Economics (3) II Applications of economics to the analysis of public policy and planning problems. P. ECON 500 or permission of instructor.

505. Methods for Policy Analysis and Program Evaluation (3) II Techniques for analyzing the effects of public policies and programs. P. ECON 500 or permission of instructor.


513. Intergovernmental Relations (3) I Legal, political and social framework of intergovernmental relationships; trends, emerging issues, and devices for securing coordination and responsibility.

514. Analytic Methods in Planning and Management (3) II Methods and models for program planning and policy analysis; forecasting, service demand, facility location in capital investment programming, task sequencing, program analysis and evaluation. P. MKTG 552, GEOG 557 or permission of instructor, (Identical with PLNG 514)

521. Social Policy (3) I Design, implementation and outcomes of social policy initiatives in the U.S. and abroad. Includes historical overview of welfare policy in the U.S., competing explanations for conditions of inequality, and examination of policy solutions (Identical with SOC 521)

522. Analysis of Health Systems (3) I Introduces the student to the scope and nature of public and private health systems in the U.S.; examines roles of government and private enterprise in the development and operation of health institutions.

523. Health and Public Policy (3) II Examines public policy issues in health, including recent developments in health policy and planning at the national, state and local levels, and their impact on administrative behavior. P. 522 (Identical with PLNG 523)

524. Management of Long Term Care Facilities and Programs (3) II Problems and principles of management of facilities and community based programs providing health and social services to the chronically impaired. P. 522.

525. Comparative Management in Health Administration (3) I Assists students in applying general management principles to particular types of health agencies. Models of organizational behavior are used to develop a paradigm for comparative analysis. P. 522.

526. Health Economics (3) II Applies microeconomic theory, industrial organization and public finance to efficiency and equity problems in the acute and chronic health-care sectors. Explores solutions to these problems. P. 522, ECON 500, or permission of instructor.

527. Aging and Public Policy (3) I Policy framework for administration of programs, plans, priorities, and legislation related to the needs of the aging in modern society (Identical with PLNG 527)

528. Topics in Public and Nonprofit Financial Management (3) II Advanced issues in public sector financial management. P. 508 or FIN 511 (Identical with FIN 528)

535. International Management (3) II (Identical with MAP 535)

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Range Management
(See Renewable Natural Resources)

Reliability Engineering
(See Systems and Industrial Engineering)

Remote Sensing (REM)
1600 North Country Club, Suite 100
Tucson, AZ 85716
(602) 621-4242

Graduate Interdisciplinary Program in Remote Sensing

Committee:

Professors Philip N. Slater (Optical Sciences) Chair, Victor R. Baker (Geosciences), Robert E. Dickinson (Atmospheric Sciences), Barry D. Ganapol (Nuclear and Energy Engineering), Lloyd W. Gay (Renewable Natural Resources), Benjamin N. Herman (Atmospheric Sciences), John A. Reagan (Electrical and Computer Engineering), Richard W. Reeves (Geography and Regional Development), Soorooch Sorooshian (Hydrology and Water Resources)

Associate Professors Charles E. Glass (Ming and Geological Engineering), Alfredo R. Huete (Soil and Water Science), Charles F. Hutchinson (Arid Lands Resource Sciences), Stuart E. Marsh (Arid Lands Resource Sciences), John W. Olsen (Anthropology), William O. Rasmussen (Agri-
Renewable Natural Resources (RNR/LAR/RA/ WSM/WFSC)

Biological Sciences East, Room 325 (602) 621-7255


Associate Professors Mark P. Frederickson, H. Randal Gimblett, Lauri M. Johnson, Gordon S. Lehman, Donald V. Lightner (Veterinary Science), R. William Mannan, William J. Matser, Mitchel P. McClaran, Bruce A. Roundy, E. Lamar Smith, Jerry Tash (Emeritus), Donovan C. Wilkin

Assistant Professors Lee A. Graham, Lisa J. Graumlich (Tree-Ring Laboratory), D. Philip Guertin, Vicente L. Lopes, Guy R. McPherson, Thomas W. Swetnam (Tree-Ring Laboratory)

The School of Renewable Natural Resources is concerned with the management and conservation of natural ecosystems with emphasis on the desert, range and forest ecosystems of arid and semi-arid environments. Graduate programs leading toward the degrees of Master of Science and Doctor of Philosophy prepare students for (1) research and teaching in the area of natural resource management and planning, and (2) positions in land management that require specialization that can be acquired through one of the available majors. All students are urged to gain a broad understanding of the social and political institutions as they affect fundamental relations of humans and their environment, particularly those involving plants, animals, soil and water resources and climate.

The program is divided into three areas of emphasis: (1) Forest Management, (2) Wildlife and Fisheries Science, and (3) Watershed Management.

Watershed Management: Concentrations are available in watershed hydrology, forest-watershed management, and range management. Students interested in careers in natural resources studies, range management, watershed management, and range management, natural resource recreation, or forestry with training in the biological, physical, and social sciences equivalent to that required for the bachelor's degree at the University of Arizona. Applicants lacking these prerequisites will be required to complete additional units in established watershed management or range management courses.

Students working toward the Master of Science degree shall complete at least thirty units including a thesis for which as many as five units may be earned.

Wildlife and Fisheries Science: This major includes specialization in wildlife ecology and fisheries science. Both programs require the completion of at least 30 units including a minimum of fifteen units of course work and an acceptable thesis focusing on original research that addresses a wildlife and fisheries management topic for the master's degree.

Renewable Natural Resources Studies: Graduate work in this major provides training and research opportunities in natural resources in combination with studies in areas such as planning, policy, administration, economics and behavioral science. This interdisciplinary program is appropriate for continuing students and mid-career professionals interested in careers in natural resources policy administration, planning, management and research. Students should have academic training in one of the resource disciplines within the school or a related field of study. The master's degree requires at least 56 units including a thesis for which six units may be earned.
Renewable Natural Resources (RNR)

504. Conservation Biology (3) II 1994-95

517. Introduction to Geographic Information Systems (3) I Computer techniques for capturing, processing, and display of geographic information, with emphasis on applications in land resources management and planning. 2R, 3L. P, basic knowledge of computer operations. (Identical with GEOG 517 and S W 517)

518. Advanced Geographic Information Systems (3) II Advanced techniques in geographic information systems database development, manipulation, and analysis, emphasizing renewable natural resource applications. Experience with advanced raster and vector-based GIS packages on workstation platforms. 2R, 3L. P, 517. (Identical with GEOG 518)

527. Artificial Intelligence in Resource Management (3) I 1993-94 Use of artificial intelligence as it applies to natural resources, including knowledge representation, problem solving, expert systems, feature recognition, neural networks, and genetic algorithms. Examples will be derived from current applications using various techniques to address management problems. P, computer programming skills.


535. Fire Ecology (3) II Ecological role and use of prescribed fire in forest and range ecosystems; fire history; concepts and specific fire effects on vegetation, wildlife, soils and watersheds. P, basic ecology course, 316 or RA M 382.

545. Principles of Research (3) II Philosophy of science and the principles of conducting research, including formulation of problems, problem analysis, study plans, and preparation of manuscripts for publication.

555. Advanced Applied Plant Ecology (3) II Discussion of advanced topics in plant ecology, with emphasis on applied ecology of terrestrial ecosystems. P, basic ecology and statistics.

575. Economics of Natural Resource Policy (3) II (Identical with AREC 575)

576. Advanced Natural Resource Economics (3) II (Identical with AREC 576)

578. Global Change (3) II (Identical with GEOS 578)

580. Natural Resources—Policy and Administration (3) II Resource policy formation; ethics of resource use; administration and organization for resource management; analysis of present policy and trends. P, 200, AREC 375.

581. Environmental Policy (3) II (Identical with POL 581)

586a-586b. Natural Resources—Management and Economics (3-5) Introduction to decision-making techniques in natural resources management, including planning, GIS, modeling, applied economics, and systems analysis techniques. 2R, 3L. P, AREC 375, RNR 271, 384.

589a-589b. Advanced Environmental Interpretation (2-2) Advanced training and experience in communication of natural history and environmental principles to the public. Students must be available for some weekend field work. 589a is part of a two-semester sequence. Credit and grade for 589a will be awarded only upon completion of 589b. Field trips. P, 12 units in biology or renewable natural resources.

590. Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

595. Colloquium

b. Public Natural Resource Management (2) II 1994-95

c. Human Dimensions in Renewable Natural Resources (3) I 1993-94

d. Topics in Forest and Range Ecology (2) II 1994-95

e. Heritage Resources Planning and Management (2) II 1993-94

596. Seminar

i. Management and Policy for Ecological Sustainability (3) [Rpt.] I II (Identical with POL 596i, which is home)

m. Conservation Biology (1) [Rpt.] I II (Identical with ECOL 596m, which is home)

597. Workshop

a. Natural Resource Conservation Workshop (1) [Rpt.] I S Field trips.

b. Desert Ecosystems (1) [Rpt.] I II

w. Advanced Cadastral Survey (1-4) II (Identical with C E 597w) P, prior training and work experience in cadastral surveying

*May be convened with 400-level course.

598. Practicum

a. Teaching in Renewable Natural Resource Studies (1-3) [Rpt.] I II

b. Teaching in Range Management (1-3) [Rpt.] I II

c. Teaching in Watershed Management (1-3) [Rpt.] I II

d. Teaching in Wildlife and Fisheries Science (1-3) [Rpt.] I II

599. Seminar

a. Renewable Natural Resources (1-2) [Rpt.] I II

b. Integrating Advanced Technology in RNR (3) I II 1993-94

697. Workshop

a. Interdisciplinary Problem Solving in Natural Resources I (2) I II P, consult department before enrolling. (Identical with HWR 697a, which is home) Note: 697a is part of a two-semester sequence. Students receive a grade of "K" at the end of the first semester. Credit and grade for 697a will be awarded only upon completion of 697b.

b. Interdisciplinary Problem Solving in Natural Resources II (2) I II P, 697a. (Identical with HWR 697b, which is home) Note: 697b is part of a two-semester sequence. Credit and grade for 697a will be awarded only upon completion of 697b.

Landscape Resources

William H. Havens, Program Leader

Landscape Architecture (L AR)

501. Site Planning and Design (4) I Planning and design problems at site scale with particular concern for conservation and energy utilization. 1R, 8S. P, 502.

502. Regional Landscape Planning and Design (5) II Planning and design problems of regional scope and emphasis. 2R, 8S. P, 501.

503. Advanced Landscape Design (3) I Issues and problems in landscape design. Relationships with architects, engineers, planners and natural resource scientists are stressed. 1R, 6L. Field trips.

504. Advanced Landscape Planning (3) II Advanced techniques in landscape planning and problem analysis including visual simulation, computer map overlay, video applications, research in perception and behavior. 1R, 6L.

507. The American Landscape (3) II (Identical with GEOG 507)

527. Field Methods in Environmental Psychology (3) II (Identical with PSYC 527)

533. Landscape Planning (3) I Theories and models in landscape planning; planning issues, methods, and case studies. Two, 2-day field trips.

538. Planting Design (3) II Application of plant materials in landscape design; principles of xeriscape and energy-conserving design. Open to majors only. 2R, 2S, P, 335 and 501.

542. History and Theory of Landscape Architecture (3) II Examination of the historical background and theoretical bases of landscape architecture.

543. Contemporary Landscape Architecture (3) I Examination of modern and post-modern design in landscape architecture. P, 542.

550. Landscape Ecology (3) II Principles and theories of spatial ecology presented in the context of land management problems in Southern Arizona. Practical application of productivity theory emphasized. Field trips. 2R, 3L.


552. Landscape Construction (4) II Introduction to construction materials and methods, working drawings and specifications related to the profession of landscape architecture. 2R, 5L. P, 551.

553. Irrigation Design (3) I Principles of irrigation system design; introduction to system...
components and applications; construction responsibilities and design liabilities. P, 552. Open to majors only.

560. Professional Practice (3) II Professional services, contract documents, contract administration, office organization, ethics, professional registration, roles of the landscape architect, the practice of landscape architecture. P, 502.

582. Professional Practice Studio (5) II Synthesis studio in landscape architecture. Complex problems in regional, site and urban planning and design. Emphasis upon "real world" problems and professional practice. Open to majors only. 2R, 7S. P, 502.

595. Colloquium
d. Landscape Architecture Research (3) I

596. Seminar
u. Interdisciplinary Environment-Behavior-Design (3) II (Identical with ENV 596u, which is home)

597. Workshop
a. Community Design for Non-Designers (3) I (Identical with ARCH 597i, which is home)

*May be convened with 400-level course.

694. Practicum
a. Landscape Architecture Teaching (1-2) I II

696. Seminar
a. Landscape Architecture (1) [Rpt.] I II

Range Resources
E. Lamar Smith, Program Leader

Range Management (RA M)

536. Grazing Ecology and Management (2) I Application of animal diet and nutrition, grazing behavior, and vegetation-soil-herbivore interactions in management of livestock production, wildlife habitat, watershed protection, forest reproduction, and other land use objectives. Includes design of water developments, fences and other structural range improvements.

546. Range Vegetation Improvement (3) I Rangeland habitat manipulation through vegetation control and establishment including mechanical, chemical, and burning treatments. Revegetation techniques for rangeland and drastically disturbed semiarid lands. 2R, 3L. P, MCB 181, ECOL 182, S W 200.

556. Rangeland Inventory and Monitoring (3) I Techniques of mapping and measuring attributes of vegetation and soils for inventory and monitoring of rangelands. Interpretation of data with respect to range condition and trend, watershed protection, value for livestock and wildlife habitat. P, RNR 202, 321.


587. Rangeland Management Plan (2) II Conduct a field inventory, develop management alternatives, and provide environmental and economic analyses of alternative management proposals in a written plan. 6L. All-day field trips. P, 556.

595. Colloquium
a. Rangeland Policy (3) [Rpt.] I II 1994-95
c. Diet Selection of Free-ranging Ruminants (2) I 1993-94

*May be convened with 400-level course.

696. Seminar
a. Rangeland Management (1) [Rpt.] I II

Watershed Resources
Richard H. Hawkins, Program Leader

Watershed Management (WS M)

508. Wildland Fire Management (3) I Principles of fire behavior in forest, range, and other vegetation types; interrelationships of fuels, weather, and topography; pyrolysis and combustion processes; effects of fire; fuels inventory; prevention, detection, and control techniques; fire danger rating and fire behavior modeling.

510. Silviculture (3) II Principles and technical procedures for reproducing and growing stands of woody plants for a variety of uses; ecologically-based forest management. Week-end field trips. P, RNR 316.


520. Photogrammetry (1) II 1994-95 Aerial photographic planning for natural resource management; stereoscopic principles applied to planimetric and topographic mapping. 3L. P or CR, 522.

522. Photointerpretation (2) II Reading and interpretation of aerial photographs; natural resource inventory from aerial photographs; remote sensing techniques. 1R, 3L.

531. Dryland Forest Management (3) II 1994-95 Utilization and management of forest resources in dry environments; biophysical and socio-economic issues related to the development of forest commodities and amenities. P, 6 units of upper-division WS M.

532. Agroforestry (3) I 1993-94 Ecological and socioeconomic factors related to the planning and implementation of agroforestry systems. P, 6 units of upper-division WS M.

534. Tree Nursery Management (3) I 1994-95 Tree nursery establishment and management, with emphasis on dryland ecosystems. P, 6 units of upper-division WS M.

535. Water Management in Dryland Ecosystems (3) I 1993-94 Hydrologic principles as applied to arid and semiarid ecosystems with water management applications in dryland resources management. P, STAT 509, S W 201. (Identical with AR L 535)

560. Watershed Hydrology (3) I Application of fundamental principles to quantifying the basic hydrologic processes occurring on watersheds. P, GEOS 101, S W 200, 201, STAT 160 or 263. (Identical with HWR 560)


562. Watershed Management (3) II Evaluating hydrologic impacts of management activities on watersheds to include silviculture, range, mining, and recreation use. 2R, 3L. P, 560.

563. Plant-Water Relations (3) II (Identical with PL S 563)

564. Introduction to Dendrochronology (4) (Identical with GEOS 564)

565. Environmental Hydrochemistry (3) II 1994-95 (Identical with S W 565)

567. Advanced Watershed Hydrology (3) II Advanced topics in watershed hydrology; rainfall-runoff, infiltration, overland flow routing, sediment modeling, statistical analysis and research methods in hydrology. P, 560.

568. Wildland Water Quality (3) II Introduction to water quality and its influences in natural environments. Interactions with land management and relationships to the larger issues of environmental quality. Field trips.

577. Advanced Topics in the Economics of Environmental Regulation (3) II (Identical with AREC 577)

595. Colloquium
c. Dendrochronology: Physical Applications (3) [Rpt./2] I II (Identical with GEOS 595e, which is home)

Dendrochronology: Biological Applications (3) [Rpt./2] I II (Identical with GEOS 595g, which is home)

Dendrochronology: Physical Applications (3) [Rpt./2] I II (Identical with GEOS 595f, which is home)

*May be convened with 400-level course.


696. Seminar
a. Watershed Management (1-2) [Rpt.] I II

Wildlife and Fisheries Resources
William W. Shaw, Program Leader

Wildlife and Fisheries Science (WFSC)

505. Aquatic Entomology (3) II 1994-95 (Identical with ENTO 505)
Russian and Slavic Languages (RUSS)
Modern Languages Building, Room 340
(602) 621-7341

Professors John Garrard, George Gutsche, Joe Malik, Jr. (Emeritus)
Associate Professors Grace Fielder, Margaret Gibson, Head, Alexander Dunkel, Delbert Phillips, Boris Roberts (Emeritus)
Assistant Professors Galina De Roeck, Teresa Polowy

The Department of Russian and Slavic Languages offers a diversified and balanced program of study including courses in literature, grammar, conversation, linguistics, and culture. All literature courses are conducted in Russian by native or near-native speakers. The emphasis is on the acquisition of practical skills as preparation for continued study, research, teaching, government service, and business careers. The program leads to a Master of Arts degree with a major in Russian. In the College of Education, the Master of Education degree with a major in Education provides an option for 15 hours of study in Russian. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Prerequisite for admission is the completion of a bachelor's degree including at least sixteen acceptable units of upper-division work in Russian.

The degree program requires the completion of at least 32 units, 27 of which must be in Russian, including 501a-501b, 507a-507b, 696c, 696d, 583 and one other linguistics course. All graduate teaching assistants must take 579. The decision regarding the requirement for a thesis will be made by the department after consideration of the student's preparation, graduate study program, and professional objectives. No more than six units may be earned for the preparation of a thesis. Students who present a thesis must pass a final oral examination while those without a thesis must pass written and oral comprehensive examinations. Those without a thesis must pass a final oral examination while those without a thesis must pass written and oral comprehensive examinations. Those without a thesis must pass a final oral examination while those without a thesis must pass written and oral comprehensive examinations. Those without a thesis must pass a final oral examination while those without a thesis must pass written and oral comprehensive examinations.

Second Language Acquisition and Teaching (SLAT)
Modern Languages Building
Room 445
(602) 621-7391

Graduate Interdisciplinary Program in Second Language Acquisition and Teaching Committee:
Professors Muriel Saville-Troike, Chair (English), Richard Demers (Linguistics)
acquisition: theory and research), or (4) second language pedagogical theory and program administration (ESL/FL methods, curriculum development, testing and evaluation, reading and writing, educational technology).

Admission to the program is based on the following kinds of evidence: (1) excellent prior academic performance in a related field as indicated by a transcript; (2) three letters of recommendation from persons familiar with the student's performance; (3) an example of the student's scholarly writing on a topic related to the proposed area of study, or a critical review of a book which is relevant; and (4) GRE Aptitude test.

In addition, the TOEFL examination is required of foreign students. All students must demonstrate a thorough knowledge of one language other than English before advancement to candidacy, judged according to criteria and procedures established by the committee. Evidence of such second language proficiency including (but not limited to) a tape recording of speech production in that language will be required prior to admission for all students applying for a graduate teaching assistantship.

Candidates for the Ph.D. will be required to complete a minimum of 78 units beyond the B.A./B.S. degree including 30 units of required courses, 18 units in one of the four areas of specialization, 12 units in a minor area of specialization, and 18 units of dissertation. It is anticipated that most students entering this degree program will hold the master's degree or its equivalent. Prior graduate level course work which is judged by the committee to be comparable to required courses in this program may be counted toward the 78 total units. Core course requirements include linguistics, sociolinguistics, and research methodology, as well as second language acquisition theory and teaching practice. A detailed listing of courses and alternatives is available from the program.

Prospective Ph.D. candidates must pass a qualifying examination no later than one year after entry into the program. Before formal admittance to candidacy all students must pass a preliminary examination in both the major and minor field of study. A final examination is required following completion of the dissertation.

Secondary Education
(See Teaching and Teacher Education)
from each of two preliminary examination areas, and (2) one course in advanced methods or statistics. Students must also pass written preliminary examinations in each of two areas and an oral examination over both areas. Finally, they must write and successfully defend, in a final oral examination, a doctoral dissertation. There is no language requirement and no requirement for a minor, although students have the option of minorning in another department.

Admission requirements: Admission to the graduate program is offered to a limited number of students demonstrating academic excellence and professional promise. To receive consideration for fall admission with financial aid, completed applications must be received by January 15. In addition to application materials required by the Graduate College, applicants must submit to the department a completed departmental application form, GRE general aptitude scores taken within the last three years, three letters of recommendation, a statement of purpose, and a sample of written work.


505. World-System Theory and Research (3) Theory and research on the modern world-system.

508. Sociology of Culture (3) Theory and research on the nature of cultural systems, cultural production and consumption, and strategies of interpretive analysis. P, consult with department before enrolling.

509. Objects and Methods of Cultural Analysis (3) From content analysis to statistical analysis, means of gathering and analyzing data on cultural objects.

510. Political Sociology (3) Basic approaches in political sociology, with emphasis on the relationship of economic and political processes.

515. Social Movements and Collective Action (3) A sociological examination of the emergence and development of social movements/collective action at both the societal and individual levels. Major theoretical perspectives on social movements/collective action will be reviewed as will recent and classical empirical works in the area. P, admission to graduate program or departmental approval.

520. Communication and the Legal Process (3) (Identical with Comm. 520)

521. Social Policy (3) (Identical with PA 521)

524. Organization Ecology (3) Survey of theory and research in organizational ecology, focusing on the organizational population as the level of analysis. Topics include population boundaries, selection vs. adaption, evolutionary dynamics.

525. Organization Theory (3) Basic review of classic and contemporary approaches to the study of complex organizations: formation, development, and internal processes.

526. Cross-National Research Methods (3) Introduction to the logic and methods of cross-national social research. (Identical with POL 526)

530. Theories and Research in Social Psychology (3) A comprehensive introduction to the major theoretical perspectives, methodologies, research areas, and issues in contemporary social psychology.

531. Socialization and Society (3) Various theoretical perspectives are applied to the content, process, and contexts of socialization throughout the life cycle to see how individuals become social beings and societal participants. P, 530, or consult department before enrolling.

532. Role, Self, and Identity (3) An examination of the concepts of role, self, and identity in relation to social action and social psychological functioning. Alternative approaches are presented, but the symbolic interactionist perspective is highlighted. P, 530, or consult department before enrolling.

533. Social Relations, Groups, and Networks (3) An analysis of social interaction in relations, groups, and networks, emphasizing the reciprocal influences of social structure and social process. Theories of exchange, power, status, and justice are considered. P, 530, or consult department before enrolling.

537. Social Cognition, Affect and Emotion (3) Theories and research that describe how we perceive and react emotionally to the social world. Topics include social attribution, stereotyping, attitude-behavior relations, social accounts, emotion culture and emotion management.

540. Theories of Crime and Public Policy (3) (Identical with PA 540)

541. Deviance and Social Control (3) Theory and research on the origins of various forms of deviant behavior, and on the consequences of efforts to control them. P, 201, 341 or 342. (Identical with PA 541)

551. Stratification and Class (3) Basic examination of concepts and research in the area of stratification, with emphasis on the classic statements and contemporary research.

552. Advanced Topics in Stratification (3) [Rpt./1] In-depth study of one contemporary area of research in stratification. Topics will vary.

556. Gender Issues in Organizational Behavior (3) (Identical with MAP 556)

557. Gender and Labor (3) Sources and consequences of gender differentiation and inequality, with attention to occupations, earnings, labor markets, household work, and the family. P, 3 graduate credits in women's studies, sociology, or economics; or undergraduate major in one of these three fields.

558. Gender Identities and Interactions (3) Examination of the interface of gender, race, class, and ethnicity in the context of social structures and institutions. Focuses upon identities and social interaction as keys to understanding how gender inequality is created, perpetuated, or altered in families, schools, peer groups, work settings, and cultural symbols. P, 3 graduate credits in sociology, social psychology or women's studies. (Identical with WS 555)

560. Race and Ethnicity (3) Analysis of recent research on the relations among racial and ethnic groups in society, with special attention to current empirical and theoretical issues.

569. Basic Quantitative Methods (3) An introduction to basic quantitative methods for professional sociologists, including computer, mathematical, and statistical concepts.

570a-570b. Social Statistics (3-3) 570a: Probability, distributions, estimation and hypothesis testing. 570b: Ordinary least squares regression, generalized least squares regression, structural equation models (path analysis and non-recursive systems).


576. Field and Observational Methods (3) Comprehensive and critical examination of the collection, coding, analysis, and presentation of ethnographic/qualitative field data. Original field research required. P, admission to graduate program or departmental approval. (Identical with COMM 576)

580. Population Studies (3) Theory and research in the fields of fertility, mortality, and migration, with emphasis on their relationships to social structure. An original research project is required.

582. Constructing Social Theories (3) The nature and fundamental types of social theories. Formulating theories to guide research across a range of substantive areas. Criteria for choosing among alternative theories.

585. Colloquium
a. Introduction to Graduate Study (1)

590. Seminar
a. Advanced Problems in Research (1-3) [Rpt.] (Note: This is a two-semester course beginning in fall which receives a "K" grade at end of first semester.)
Soil and Water Science (SW)

Shantz Building, Room 429
(602) 621-1646


Associate Professors David M. Hendricks, Alfredo R. Huete, Allan D. Matthias

Assistant Professors Mark L. Brusseau, Raina M. Miller, Thomas L. Thompson

The department offers opportunities for study toward the Master of Science and Doctor of Philosophy degrees with a major in soil and water science. Areas of emphasis are available in soil science, environmental science, and soil-plant-water relations. Areas of concentration in soil science include soil physics, soil chemistry; soil biology; soil genesis, morphology and classification; and soil mineralogy. Areas of concentration in environmental sciences include environmental chemistry, environmental microbiology; waste management and pollution control; water quality; and remote sensing of terrestrial ecosystems. Soil-plant-water relations include soil-water management and soil fertility and plant nutrition.

Students with adequate undergraduate preparation in physical sciences, biological sciences, earth sciences, and engineering will be considered for admission to an appropriate degree program. A thesis is normally required for the M.S. degree, but may be waived for a student who is a senior author of a manuscript published or submitted for publication to a refereed professional journal. A non-thesis option is also available to qualified students in the environmental science area of emphasis with approval of the department head.

A minor is available with a minimum of 12 units of soil science courses required which includes three of the following courses: W 511, 531, 570, 525 or 602.

501.* Management of Arid Lands and Salt-Affected Soils (3) II Principles and practices of soil, water and crop management under arid and semiarid conditions, the use of diagnostic procedures for evaluating soils and waters, reclamation, and economics of irrigation project development. 2R, 3L. Field Trips.

504.* Irrigation Principles and Management (3) II (Identical with ABE 504)

505.* Environmental and Soil Analysis (3) II Principles and methods of chemical analysis of soils, water and biological materials emphasizing properties of agricultural and environmental significance. 1R, 6L. P, CHEM 322, 323; PHYS 102b, 180b. Hendricks/Artiola/Brusseau

511.* Soil Chemistry (3) I Soil chemical interactions with water, air, plants and pollutants. 2R, 3L. P, 200, CHEM 103b, 104b. Bohn/Hendricks

517.* Introduction to Geographic Information Systems (3) II (Identical with RNR 517)

520. Physics of Plant Environments (3) I 1993-94 Principles of energy, momentum, and gaseous exchanges within the environments of agricultural land surfaces; emphasis on models and measurements of potential and actual evaporation of water. P, MATH 125b, PHYS 102b. Matthews

525. Environmental Microbiology (3) I (Identical with MBIM 525)

526. Environmental Microbiology Laboratory (2) I Basic techniques for isolation and characterization of environmental soil and water microflora including methods for enumeration and measurement of physiological activity. P. 425. (Identical with MBIM 526)

530.* Environmental Measurements (3) I Theory and application of environmental measurements to the sampling and monitoring of groundwater, soil, surface water, and near-surface atmospheric systems. 1R, 6L. P, HWR 450 or HWR 517 or SW 511 or equivalent. Artiola/Brusseau/Mathias

531.* Soil Morphology, Classification and Survey (3) I Theory and practice of describing characteristics of soils; principles of soil classification and the classification systems; methods and applications of soil surveys. 2R, 3L. Field trips. P, 200, 201. Post

540.* Biodegradation of Pollutants in Soil and Groundwater (3) II Description of modern pollution problems and potential biological mediation techniques focusing on the chemistry, biochemistry and molecular biology of biodegradation of hazardous and toxic compounds. P, MIC 425. (Identical with MBIM 540) Miller

541. Soil Genesis (3) I 1994-95 Physical and chemical processes and mineralogy of weathering and soil formation; quantitative pedology; the soil as part of the ecosystem. Field trips. P, GEOS 101 and CHEM 103b. (Identical with GEOS 541) Hendricks


550.* Anticipating the Future: Focus on Environment (3) II Techniques to understand broad issues about the future with focus on environmental topics. Uses computer conferencing and significant student discussion with opportunities for team approaches and reporting.

553.* Remote Sensing of the Environment (3) II Remote sensing techniques and applications for improved natural resource utilization of soils, water, grasslands, and forest. Fundamental energy-matter interactions that influence the spectral characteristics of vegetation, soil, and water. 2R, 3L. Field trips. P, 330 or PHYS 102b. Huete


565. Environmental Hydrochemistry (3) II 1994-95 The occurrence, transport, and fate of organic and inorganic contaminants in the subsurface environment. Emphasis on the physical, chemical, and biological processes influencing transport and fate in unsaturated and saturated zones. Transport and fate models are discussed. P, 470 or HWR 407 or 431, CHEM 480a. (Identical with WS M 565) Brusseau

566.* Soil and Groundwater Restoration (3) II 1993-94 Methods for remediating contaminated soil and groundwater; factors influencing efficacy of remediation systems. Emphasis on scientific basis of restoration. Brusseau

570.* Soil Physics (3) II Soil structure and physical constitution of soils; the physical properties of soil-water systems, movement and exchange of gases in the soil, and physical laws governing the movement and availability of soil water. 2R, 3L. P, 200, PHYS 102b, CR, MATH 125a. Warrick

573. Monitoring Biosphere Processes (2) I 1994-95 Global-scale interactions of soils with their plant cover and climate. The spatial distributions and dynamics of soil-plant-water processes with emphasis on measurements from space. P, 200; 330 or 453. Huete

590.* Remote Sensing for the Study of the Planet Earth (3) II 1993-94 (Identical with REM 590)

*May be counted with 400-level course.

602. Soil-Plant Relationships (3) I Principles of soil solution and colloid chemistry, soil-water relationships, soil microbiology, and plant physiology and metabolism will be discussed. These principles will be applied to process of soil nutrient cycling, nutrient availability, and plant growth. P, 200. Thompson

605. Soil-Water Dynamics (3) II 1994-95 Water flow in soils; closely related problems of solute, pollutant, and heat transfer; emphasis on current concepts and research. P, MATH 254. (Identical with HWR 605) Warrick

694. Practicum

696. Seminar
a. Topics in Soil, Water and Environmental Science (1) [Rpt/4] I II
The Southwest Center

Southwest Studies are designed to bring new perspectives to regional subjects through an interdisciplinary approach. Courses on the Southwest are taught through many university departments and programs, including American Indian Studies, anthropology, English, geography, history, Latin American studies, linguistics, Mexican American studies, political science, sociology, Spanish and Portuguese, and women's studies. For information, contact the Southwest Center.

Spanish and Portuguese (SPAN/PORT)

Modern Languages Building, Room 545
(602) 621-3123

Professors Charles M. Tatum, Head, Leo L. Barrow, A. Dolores Brown (Emerita), Jack Emory Davis (Emeritus), John J. Gilabert, Lánín A. Gyurko, Richard P. Kinkade, Miguel Méndez, Dana A. Nelson, José Promis, Eliana S. Rivero Associate Professors Gilbert E. Evans, Karl C. Gregg, Judith Nantell, Karen L. Smith, H. Reynolds Stone Assistant Professors Maria José Barbosa, June Jaramillo, Ana Perches, Robert N. Smead, Amy Williamsen, Mary Zamperini

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Spanish. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in Spanish; for information concerning this degree see Requirements for Master's Degrees in Education elsewhere in this catalog. For those students in other departments, the Department of Spanish and Portuguese offers a doctoral minor in Spanish.

Admission to all graduate programs requires the completion of a bachelor's degree with a major in the proposed field of study. Admission to the doctoral program in Spanish is dependent upon the completion of a Master of Arts degree in Spanish at the University of Arizona or elsewhere.

All GATs in Spanish are required to complete a language teaching methodology course during their first semester of classroom teaching.

Degrees

Master of Arts (Major in Spanish): a minimum of 30 units in one of two concentrations.

1. Hispanic literature concentration.

Admission: The applicant must hold or anticipate completing by the time of admission a bachelor's degree from an accredited U.S. college or university or the equivalent degree from a foreign university. The applicant is expected to have a minimum of 15 semester hours of Hispanic literature courses at the advanced level and one advanced Spanish grammar and composition course or the equivalent of the undergraduate major in Hispanic literature at the University of Arizona; to have a minimum grade-point average of 3.3 on a 4-point scale overall; and to have a minimum grade-point average of 3.4 on a 4-point scale in Spanish.

Requirements: Upon entering the program, the student establishes his/her degree program in consultation with the Director of Graduate Studies. The student is required to complete a minimum of 30 graduate units with equal concentration in Spanish and Spanish-American literature, a 3-unit seminar in Hispanic literature, a 1-unit proseminar, and a general written examination in the field of Hispanic literature.

2. Hispanic linguistics concentration.

Admission: The applicant must hold or anticipate completing by the time of admission a bachelor's degree from an accredited U.S. college or university or the equivalent degree from a foreign university. The applicant is expected to have a minimum of one advanced Spanish grammar course and one advanced Spanish conversation and composition course; to have a minimum of 9 semester hours in areas including Spanish phonetics and pronunciation; advanced Spanish syntax, and general linguistic theory or their equivalent; to have a minimum grade-point average of 3.3 on a 4-point scale overall; and to have a minimum of 3.4 on a 4-point scale in Spanish.

Requirements: Upon entering the program, the student establishes his/her degree program in consultation with the Director of Graduate Studies. The student is required to complete a minimum of 30 graduate units in Hispanic linguistics distributed as follows: 9 units in second language theories and applications, 9 units in general introductory Hispanic linguistics, and 9 units in linguistic theories and applications. In addition, the student is required to complete a 3-unit seminar in Hispanic linguistics; 1-unit proseminar; and a general written examination in the field of Hispanic linguistics.

Doctor of Philosophy (Major in Spanish)

Admission: The applicant must hold or anticipate completing by the time of admission an M.A. degree from an accredited U.S. college or university or the equivalent degree from a foreign university, have a minimum grade-point average of 3.4 on a 4-point scale in the M.A. in Spanish, and meet the general requirements of the Graduate College.

Requirements: Upon entering the program, the student establishes his/her degree study program in consultation with the Director of Graduate Studies. The student must (1) complete a minimum of 36 graduate units; (2) complete a 1-unit proseminar and at least two 600-level seminars; (3) present a reading knowledge of one foreign language, other than English or Spanish, appropriate to the field of specialization; (4) pass a comprehensive examination, partly written and partly oral, in the primary field of study and in two secondary fields of study; and (5) complete 18 doctoral dissertation units, write and defend a dissertation.

In consultation with the Director of Graduate Studies, the student selects one primary field of study from the following areas: (1) medieval, renaissance, and golden age Spanish literature; (2) eighteenth, nineteenth, and twentieth-century Spanish literature; (3) Spanish American literature from the Pre-Columbian period to independence; and (4) nineteenth and twentieth-century Spanish American literature. In addition, the student selects two secondary areas of study outside the primary field from the following areas of study: (1) thirteenth-century through eighteenth-century Spanish literature; (2) nineteenth and twentieth-century Spanish literature; (3) Pre-Columbian through eighteenth-century Spanish American literature; (4) nineteenth and twentieth-century Spanish American literature; and (5) Mexican and Mexican American literature. The student may select elective courses offered in the department from the following areas of study: (1) Hispanic linguistics, and (2) Luso-Brazilian literature; (3) literary theory; (4) Hispanic women writers.

At least 18 units must be taken in the primary field of study and 6 units in each of the two secondary areas of study. The
remaining 6 units are electives. A student whose major field is in Hispanic American literature must choose one secondary field in Spanish peninsular literature and vice versa.

Spanish (SPAN)

501. Development of Spanish Medieval, Renaissance, and Golden Age Literature (3) Spanish medieval, renaissance, and golden age literature (short fiction, poetry, novel and drama) from the twelfth through the seventeenth century.

511. Topics in Medieval Literature, Renaissance, and Golden Age Literature (3) [Rpt./3 when topic varies] Representative topics include the development of lyric poetry, Mester de Clarecia, Ugarit, and Romanero, the development of prose; Renaissance and Baroque prose; Renaissance and Baroque poetry; Cervantes' Don Quixote and other representative works; Golden Age drama of the sixteenth and seventeenth centuries.


521. Topics in Eighteenth, Nineteenth and Twentieth-Century Spanish Literature (3) [Rpt./3 when topic varies] Representative topics include Spanish romanticism; nineteenth-century realist and naturalist Spanish prose; Generation of '98; modern Spanish prose fiction; modern Spanish poetry; the contemporary novel of the post-Franco era; contemporary Spanish poetry; modern and contemporary Spanish theater.

530. Development of Spanish American Literature from the Pre-Columbian Period to Independence (3) Spanish American literature from the Pre-Columbian period to independence (short fiction, poetry, novel and drama). (Identical with LAS 530)

531. Topics in Spanish American Literature from the Pre-Columbian Period to Independence (3) [Rpt./3 when topic varies] Representative topics include Pre-Columbian Aztec, Mayan, and Maya-Quiche literature; the chronicle; Renaissance and Baroque poetry.

540. Development of Spanish American Nineteenth and Twentieth-Century Literature (3) Spanish American nineteenth and twentieth-century literature (short fiction, poetry, novel and drama). (Identical with LAS 540)

541. Topics in Spanish American Nineteenth and Twentieth Century Literature (3) [Rpt./3 when topic varies] Representative topics include: nineteenth-century Spanish-American prose fiction; modernismo; modern Spanish-American prose fiction; modern Spanish-American poetry; contemporary Spanish-American prose fiction; contemporary Spanish-American poetry; modern and contemporary Spanish-American theater; trends in the Spanish-American short story.

550. Development of Mexican and Mexican American Literature (3) Mexican and Mexican-American literature (short fiction, poetry, novel and drama) (Identical with MAS 550)

551. Topics in Mexican and Mexican-American Literature (3) [Rpt./3 when topic varies] Representative topics include: novel of the Mexican revolution; trends in Mexican and Mexican-American films; trends in contemporary Mexican literature; Mexican American prose fiction since 1965; trends in Mexican-American theater; major movements and authors of Mexican-American literature.

561. Topics in Hispanic Literature (3) [Rpt./3 when topic varies] Representative topics include Hispanic women writers; U.S. Hispanic literature; trends in modern and contemporary Spanish and American film.

571. Topics in Literary Theory and Criticism (3) [Rpt./3 when topic varies] Topics include historical overview of major developments in literary theory and criticism with theoretical and critical analysis of Hispanic texts.

574.* Linguistic Perspectives on Mexican-American Spanish and Bilingualism (3) II Focuses principally on descriptive linguistic analyses of Chicano language phenomena examined in sociolinguistic and psycholinguistic contexts. Analysis will include phonological and phonetic levels, although the primary emphasis will be on morphosyntactic and lexical realizations. Macro-sociolinguistic tools of languages in contact/conflict, language shift, language choice/preference, and language attitudes as well as specific linguistic behaviors associated with Chicano bilingualism will also be treated in detail. P, 310 (Identical with LING 574 and MAS 574)

580. Introduction to Hispanic Linguistics (3) [Rpt./3 when topic varies] Introduction to Hispanic linguistics. Representative topics include introduction to Spanish phonology, introduction to Spanish morpho-syntax, history of the Spanish language; Spanish in the Americas.

581. Topics in Second Language Linguistic Theories and Applications (3) [Rpt./3 when topics vary] Various topics, such as theories and techniques of teaching Spanish, theories of second language acquisition, applied linguistics, theories of second language evaluation.

582. Topics in Hispanic Linguistic Theories and Applications (3) [Rpt./3 when topic varies] Various topics such as Hispanic sociolinguistics, theoretical issues in Spanish phonology; Spanish semantics; linguistic perspective on Mexican-American Spanish.

596. Seminar (3) [Rpt./3 when topic varies] Various topics such as Hispanic sociolinguistics, theoretical issues in Spanish phonology; Spanish semantics; linguistic perspective on Mexican-American Spanish.

701. Testing and Evaluation in Foreign/Second Language Programs (3) (Identical with GER 587)

*May be convened with 400-level course.

Portuguese (PORT)

501.* Lusophone Literature to 1900 (3) Overview of literary periods and introduction to the major literary figures of Portugal, Brazil, and the Lusophone African countries (Angola, Mozambique, Cape Verde, Guine-Bissau, and Portuguese). From the beginning of their literature to the present. P, 301a-301b.

530.* Brazilian Civilization (3) 1993-94 A broad survey of Brazilian culture. Thematic examination of some of the major cultural developments. Topics include: Brazilian popular music, Afro-Brazilian culture, the role of women in Brazilian society, Brazilian popular culture. P. 325.

549.* Brazilian Literature in Film (3) 1994-95 The masterpieces of Brazilian literature and the great films based upon them. P. 301a or 301b. (Identical with LA 5 549)

563. Studies in Brazilian Literature (3) 1993-94 Major works, authors and tendencies in modern Brazilian literature. P. 301a-301b. (Identical with LAS 563)

564. Studies in Portuguese Literature (3) II Major works, authors and tendencies in the literature of Portugal. P. 301a-301b.

596. Seminar (3) [Rpt./6 units] I Mexican-American Heritage Bibliography - A Library Seminar (3) (Identical with MAS 596m, which is home) *May be convened with 400-level course.

Special Education and Rehabilitation (SER)

Education Building, Room 412 (602) 621-7822

Professors Amos P. Sales, Acting Head, Candace S. Bos, James C. Chalfant, William C. Healey, Bob G. Johnson (Emeritus), Jeanne Mccrea McCarthy, Inez Tucker (Emerita) Associate Professors Shirin D. Antia, Daniel Head, C. June Maker, S. Mae Smith, John Umbreit Assistant Professors Nancy Eldredge, James Organist, Samuel Supalla

The department is committed to scholarship and leadership in the development of theory and practice related to the empowerment of individuals with disabilities and special abilities. The department's research, teaching, and service address current issues in special education, rehabilitation, and sign language studies.

The department offers programs leading to the Master of Arts, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in special education and rehabilitation. Concentrations focus on rehabilitation
counseling including counseling of the deaf.

An undergraduate grade-point average of at least 3.00 is required for admission to full standing in a graduate degree program. However, applicants with an undergraduate grade-point average of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the department.

*At the time of catalog production, the Master of Education degree with a major in special education was under review. Consult the department or college regarding the status of this degree program.*

500. Foundations of Special Education and Rehabilitation (3) I II General characteristics of exceptional/disabled persons in interrelated human service delivery systems.

501a. Assessment and Instruction for Students with Learning Problems (3) I II Procedures, methods, strategies for informal diagnosis and remediation of students with learning problems in the areas of reading, spelling, handwriting, written expression, mathematics and socialization. Strategies and adaptations appropriate for use in the regular elementary or the special classroom.

502. Behavior Principles for the Handicapped (3) I II Use of behavior principles to modify the behavior of handicapped persons, especially moderately and severely handicapped, 3R, 1L. P. 400.

503. The Special Services in the Schools (3) I II S Information to aid teachers in dealing with responsibilities and concerns in school settings with regard to P.L. 94-142. Education for All Handicapped Children Act Section 504 of the Rehabilitation Act, Family Education Rights and Privacy Act, and other legal issues.

504. Cultural and Linguistic Diversity in Exceptional Learners (3) I Provides a theoretical base and practical approach to the study of special needs of students with language and cultural differences: basic premises of bilingual special education and the interface of the two fields.

505. Introduction to Learning Disabilities (3) I II Theories and history of programs for the learning-disabled—definition, characteristics, and etiology. Degree candidates must complete 500 prior to taking 505.


507a-507b. Methods for Diagnosing Specific Learning Disabilities (3-3) I Educational and psychological assessment of academic areas and learning processes involving perception, integration, and expression, with emphasis on informal and formal assessment and diagnostic teaching. P, CR. 405/505 or department permission; 593.

508. Teaching Elementary Students with Learning Disabilities (3) II Remediation of academic areas and cognitive processes involving perception, integration, and expression, with emphasis on strategies for planning and implementing instructional programs at the elementary level. P. 405/505, 507a-507b and permission of department; CR, 593, 594.

510. Introduction to Mental Retardation and Severe Disabilities (3) I History and philosophy of educational programs for persons with mental retardation and—definition, characteristics, etiology, classification, and professional considerations of educational, social, and psychological problems. P. 400 or CR.


513. Educating Students with Mental Retardation and Severe Disabilities (3) II Methods of developing age-appropriate and functional programming, integration, community-based instruction, and integrative source delivery for students who have moderate to profound retardation and other physical, sensory and behavior disorders.

515. Physical and Multiple Disabilities (3) I II Physical and multiple impairments, etiology, intervention practices, adaptations needed, transferring and handling skills, and integration into typical environments. Field trips.

518. Nonoral Communication (3) I II Techniques for assessment and intervention of alternative communication skills other than speech for students with severe disabilities. Nonsymbolic communication skills development for all ages; social interaction skills; augmentative communication aids.

520. Low Vision and Visual Functioning (3) I Vision disabilities; implications of visual field losses; introduction to optics; use of optical and nonoptical aids in classroom settings; clinical and low vision assessment, including assessing children with multiple impairments; and report writing. P, 521.

521. Introduction to Visual Impairments and Deaf-Blindness (3) I An overview of educational services for the student with visual impairments and multiple sensory impairments. An emphasis is placed on the psycho-social effects of visual impairments on the individual and means of compensating for those effects.

522a. Orientation and Mobility for Teachers of Individuals with Visual Impairment I (3) II Methods of teaching orientation and mobility skills to visually impaired and blind students. Emphasis on the school-aged child, with particular attention to concept development, orientation skills, pre-cane skills, personal safety, and independent ambulation, including an introduction to long-cane techniques.

523a-523b. Tactile Communication (3-3) I II Designed to develop intermediate ASL conversational skills in a variety of settings, topics, and functions. P, 537b or department permission. Must be taken in sequence.

524. Methods of Teaching the Visually Handicapped (3) I II Curriculum development and adaptation in various educational programs; adaptation of classroom materials and procedures for use with blind and partially sighted children and youth; emphasis on methods of teaching academic and nonacademic skills and on educating students with nonhandicapped peers. P, 521; CR, 593.

525. Strategies of Vocational Development and Supported Employment (3) I II Systematic study of the strategies used to place and retain individuals with disabilities in paid, community employment. Topics to include job development, consumer assessment, job placement, job-site training, and follow-up. P. 400.

530. Education and Rehabilitation of Deaf and Hard of Hearing Individuals (3) I Current and historical perspectives; educational and rehabilitative services; effects of communication disorders on families, psychosocial, cognitive and intellectual development and functioning of hearing impaired individuals.

531a-533b.* American Sign Language (4-4) I II Designed to develop intermediate ASL conversational skills in a variety of settings, topics, and functions. P, 530/500, SP H 505.

533a-533b.* Special Topics in Deaf Studies (3-3-3) I II 533a: Introduction to the structure of ASL; 533b: Language and culture for the deaf; 533c: History of the deaf community; 533d: ASL literature. Classes will be offered on a rotating basis in a-b-c-d sequence; however, courses need not be taken in sequence. P, 431b or permission of department.

534. Language Development for the Exceptional Child (3) I Pragmatic, semantic and syntactic aspects of pre-linguistic and linguistic development in exceptional children and youth; cognitive and social bases of language development.

535. Assessment of Bilingual Exceptional Learners (2) I II Educational and psychological assessment of bilingual students with emphasis on informal and formal evaluation methods and procedures for purposes of identification and educational planning. P. 507.

536. Teaching Bilingual Exceptional Learners (2) I II Instructional and program development for exceptional students from culturally and linguistically diverse backgrounds. Emphasis on current intervention methods and practices. P. 508.
537. Language and Reading Intervention for Deaf and Hard of Hearing Children (3) II Receptive and expressive language assessment techniques of language and reading intervention and remediation for deaf and hard of hearing children and youth. P. 534; CR, 594a.


539a-539b-539c.* Special Topics in Sign Language Studies (3-3-3) I II Classes will be offered on a rotating basis in the following sequence—539a: ASL Acquisition and Bilingualism; 539b: Language Policy, Planning and Intervention; 539c: Methods and Materials of ASL Instruction. Courses need not be taken in sequence. P. 431b or permission of department.

540.* Education of Gifted Children (3) I Issues in education of the gifted; discussion of definitions, characteristics, development, screening, identification, curriculum, teaching strategies, and program development. P. 400.

541. Teaching the Gifted: Questioning Strategies (3) II Mastery of skills involved in developing abstract thinking abilities in gifted children by using the Hilda Tabu Teaching Strategies. Emphasis on using these sequential questioning methods in all content areas and at all grade levels. P. 440/540.

542. Teaching the Gifted: Productive Thinking Models (3) I Mastery of skills involved in developing productive thinking abilities in gifted children by using teaching-learning models developed by Parnes, Williams, Taylor, Guilford, Renzulli and Trefflinger at all grade levels and in all content areas. P. 440/540.

543. Teaching the Gifted: Hierarchical Models (3) I 1980-91 Introduction to general principles involved in providing a curriculum for the gifted. Overview of ten teaching-learning models commonly used with the gifted. Mastery of skills involved in using the hierarchical models with gifted students. P. 440/540.

544a-544b-544c. ASL Discourse Processes (3 to 6-3 to 6-3 to 6) S 544a: Intensive ASL. 544b: Introduction to Interpreting. 544c: Classroom instruction in ASL. Courses need not be taken in sequence. P. 431b or permission of department.

550.* Introduction to Emotional or Behavioral Disorders (3) I Issues in education of the behavior disordered; discussion of history, current issues, definitions, characteristics, and theoretical perspectives. P. 400.

551. Teaching Children with Emotional or Behavioral Disorders (3) II Assessment techniques, academic and behavior intervention strategies, and classroom management with emotionally or behaviorally disordered children and youth.

555.* Rehabilitation of the Aged (3) II Emphasis on aging from the viewpoint of the aging person and those working with the aged.

560.* Introduction to Early Childhood Special Education (3) I Focuses on the disabling conditions impacting on preschool children, programs available to serve them and critical issues in this rapidly evolving field. P. 400.

561. Methods of Teaching Preschool Children with Disabilities (3) II Deals with competencies required to teach all categories of disabilities found in preschool children except deaf/blind. Field trips. P. 460, 560, 562, 575, CR 593.

562. Methods of Assessment for Preschool Children with Disabilities (3) I Normal-referenced and criterion-referenced instruments for screening, diagnosis and assessment of infants, toddlers, and preschool children will be reviewed. Emphasis will be placed on teacher involvement in the assessment process. P. 400/500.

563. Client Assessment in Rehabilitation (3) II Exploration of the world of work; critical review of vocational choice theories; experiences in the use and interpretation of individual assessment techniques. P. 565 or CR; ED P 458.

565. Principles of Rehabilitation (3) I Principles underlying rehabilitation programs and interdisciplinary relationships of agencies engaged in rehabilitation services.

568. Transition Methods (3) II Provides an understanding of effective strategies for promoting the smooth transition of students with disabilities from school to work and adult living.

570. Administration of Special Education Programs (3) I Practical aspects of organization and development of special education programs, including philosophy, issue resolution, public relations, personnel, case finding, evaluation, placement and records systems. P. consult director before enrolling.

571. Supervision of Special Education (3) I Practical aspects of supervising special education programs and services; curriculum development, service delivery models, staff development, program development, and legal issues and requirements.

572. Policy and Program Analysis in Special Education (3) I Practical aspects of policy analysis and program development/evaluation in schools and other social agencies that serve youth with disability and/or giftedness.

575. Observation and Participation in Special Education Programs (1-3) [Rpt./6 units] I II Specific types of exceptional individual, psychological and educational implications and practices. Field trips, class observations and seminars. P. 400/500.

578.* Prevention of Addictions (3) I Analysis of addictive behaviors (e.g., drug addictions, eating disorders, compulsive gambling) from a psychosocial and biological perspective and the implications of this analysis for primary, secondary, and tertiary prevention of addictions.

580. Medical Aspects of Disability (3) I Etiology, therapy, and prognosis of the major disabilities, including drug and alcohol; assessment of physical capacities and limitations; typical restorative techniques.


582. Principles and Practices of Vocational Evaluation (3) I Understanding work skills and labor market conditions; process of vocational evaluation of rehabilitation clientele; collecting and synthesizing evaluation data and writing meaningful reports.

583. Counseling Practices in Rehabilitation Setting (3) I Facilitation training of rehabilitation professionals in their implementation of counseling practices with varied ethnic, age, disability, and dependency populations. 3R, IL. Open to majors only.

584.* Problems of Drug Abuse (3) [Rpt./1] II Survey course for teachers, counselors, and agency workers concerned with drug abuse; examination of community, cultural, and educational approaches to drug use and abuse.

585. Vocational Planning and Placement (3) II Problems of physical, mental, social, and emotional disability, as they relate to the formulation of a rehabilitation plan; exploration of the various sources of occupational and career choice information, job placement and development. P. 565, 580, 563 or CR.

586. Psychosocial Assessment of the Deaf Person (3) I Selection, administration, and interpretation of various psychosocial evaluation instruments used with deaf persons. P. ED P 673, 674a.

587. Construction and Development of Assessment Samples (3) I II Use of occupational information, career exploration and job analysis techniques; development, construction, standardization, and use of work samples and related vocational assessment techniques. P. 565, 582, 563.

588. Professional Problems and Ethical Concerns in Rehabilitation Psychology (3) I Introduction to the field of rehabilitation psychology including an examination of ethical and legal considerations in the practice of rehabilitative psychology, foundational material in professional psychology, and an overview of the rules and functions of rehabilitation psychology.

589. Counseling and Case Practices with the Deaf (3) II Principles, methods, and techniques of counseling and case practices with deaf people in rehabilitation settings. P. 583.

590. Applied Research with Exceptional Learners (3) I II Review of principles and practices underlying applied research with exceptional learners; practice in preparation of research proposals; conduct of research emphasized.

593. Internship (1-12) I II Special sections in each concentration to be arranged in the department office.

594. Practicum
   a. Communication Development for Deaf and Hard of Hearing Children (1-6) I II
c. Teaching the Gifted (1-6) [Rpt./9 units] I II S CR 440, 541, 542, 543.

595. Colloquium
a. *Substance Abuse Education (1) II
b. Language Learning and Reading Disabilities (3) II (Identical with LING 595b)
c. Mental Retardation and Severe Disabilities (3) II P, 400.
d. Recent Advances in Special Education and Rehabilitation (3-6) II

e. Bilingual Special Education (2) I
f. Emotional or Behavioral Disorders (3) I Open to majors only.
g. Group Processes (3) I II

597. Workshop
a. Creativity and Giftedness (3) [Rpt./9 units]
b. Woodcock-Johnson - Revised (1) S. Open to majors only.

*May be conved with 400-level course.

695. Colloquium
a. Issues, Trends, and Futures in Special Education: Doctoral Think Tank (3) II
b. Emotional or Behavioral Disorders (3) II

c. Rehabilitation Psychology (3) [Rpt./9 units] I II

d. Learning Disabilities (3) I
f. Sensory Impaired (3) II

g. Issues and Research in Educating the Gifted (3) [Rpt./9 units] II
h. Rehabilitation Administration (3) I II
j. Rehabilitation of the Deaf (3) I II

551. *Language Acquisition (3) II Principles and processes of first language acquisition described in relation to children's social and cognitive development; first language acquisition processes compared and contrasted to child and adult second language acquisition and language disorders. P, 350. (Identical with LING 551)


553. Developmental Language Impairments (3) I Topics include: language and non-language characteristics and clinical management of children with developmental language impairment, acquired aphasia, bilingualism and auditory disorders.

554. Adult Aphasia (3) II Etiology, evaluation and therapy for language disorders associated with brain damage. P, 370, 350 or 551.

555. Developmental Language Disorders (3) I Research and clinical perspectives on etiology, changing symptomatology, and management; attention to related deficits, syndromes, learning disabilities, and multicultural issues. Case study focus. P, 431 or 551.


558a-558b. Intermediate Clinical Studies: Speech-Language Pathology (1 to 3—1 to 3) [Rpt./9 units] I II S Under faculty supervision, students assess speech and language functions, develop treatment plans, and carry out remedial programs based on empirical data and current technology. 558b is in an extern setting. Open to majors only. P, 451 or 571.

559a-559b. Intermediate Clinical Studies: Audiology (1 to 3-1 to 3) [Rpt./9 units] I II S Under faculty supervision, students assess hearing impairments, formulate objectives, and carry out remedial programs with emphasis on the application of research data and current technology to clinical treatment. Open to majors only. 559a is for majors concentrating in audiology; 559b is for majors concentrating in speech-language-pathology. P, or CR, 589.

560R. *Speech and Hearing Science Instrumentation (2) I Consideration of some common and specific instruments and methods employed in speech and hearing laboratories and clinics. P, 260, 280 or CR.

560L. *Speech and Hearing Science Instrumentation Laboratory (1) P, CR, 560R.

562. Psychophysical Acoustics (3) II Experimental procedures and instrumentation; study of psychoacoustics; stimulus integration, pitch and loudness limen and scales, masking, and auditory fatigue; binaural hearing; theory of signal detection. P, 280, 460.

563. Microcomputer Applications (2) II Basic understanding of microcomputer operations and its multiple functions; emphasis on computer literacy, administrative/clinical applications and hands-on instruction.

567. Experimental Phonetics: Physiology (3) Systematic examination of current experimentation and research in speech as motor behavior, with emphasis on physiological investigations of normal respiration, phonation, resonance, and articulation; critical evaluation of research design. P, 260. (Identical with PSYC 567)

568. Experimental Phonetics: Acoustics and Perception (3) Systematic examination of current experimentation and research in speech as acoustical and perceptual phenomena; critical evaluation of research design. P, 260. (Identical with PSYC 568)

570R. Evaluation Process (2) I Study of principles, methods and selected procedures involved in the assessment of individuals with communication disorders; attention to skills in interviewing and preparation of reports. P, 370, 483; CR or subsequent registration in 570L (for majors).

570L. Laboratory in Evaluation Process (1) I II Open to majors only. P, 570R or CR.

571R. *Articulation Disorders and Therapies (2) I Etiology, diagnosis, prognosis, and therapy for the articulatory aspects of communication problems. P, 350; 370a; 367; CR or subsequent registration in 571L (for majors).

571L. *Laboratory in Articulation Disorders (1) I Open to majors only. P, 571R or CR.


574. Cleft Palate, Other Craniofacial Disorders, and Communication (2) II Communication disorders associated with cleft palate and other craniofacial defects. Speech assessment, evaluation and treatment; survey of dental and surgical services. P, 471R/L or 571 R/L.


576. Communicative Aspects of Aging (2) I Hearing, speech, voice, and language changes in the elderly caused by aging and disease. Emphasis on management of these problems. (Identical with GERO 576)


580. Community and Industrial Audiology (2) II Hearing conservation in industry, schools, and the community; auditory and non-auditory effects of noise, noise assessment, control, and protective procedures.


582. Hearing Disorders and Special Tests (3) II Pathologies of the hearing mechanism, and their auditory manifestations. Special audiological procedures to differentiate site of lesion.

583. Principles of Audiology (3) (Rpt. 2 or 9 units) I II Basic principles and techniques of audiological testing, etiologies of hearing impairment, and intervention strategies. P, 260 or graduate standing.

584. Audiologic Rehabilitation: Adults (3) I Speech reading; auditory training; problems encountered with amplification units; social, psychological, educational, speech, and language difficulties encountered by the hearing handicapped. P, 280, 483.


588. Advanced Audiologic Evaluation (3) I Principles and techniques of administering and interpreting the comprehensive audiologic evaluation. 3R, 3L. P, 280, 483.

590. Research Methods in Communication Sciences and Disorders (3) II Design and execution of descriptive and experimental research in communication sciences and disorders.

608a-658b. Advanced Clinical Studies: Speech-Language Pathology (1-3) I II With facility consultation and supervision, students assume responsibility for all aspects of case management of children and adults. Exposure to clinical research methods and interdisciplinary staffings. 658b is in an extern setting. P, 558a or 558b.

659. Advanced Clinical Studies: Audiology (1-3) I II With facility consultation and supervision, students assume responsibility for all aspects of case management of adults and children. Exposure to clinical research methods and interdisciplinary staffings. Open to majors only. P or CR, 589.


693. Internship
a. Speech Pathology (1-6) I II Open to majors only.
b. Audiology (1-6) I II Open to majors only.

695. Colloquium
a. Motor Control (2) I I Identical with EXS 695a
b. Experimental Phonetics (1-3) I I

696. Seminar
a. Clinical Audiology (1-3) I
b. Experimental Phonetics (1-3) I

Statistics (STAT)

Economics Building, Room 200 (602) 621-4158

Professors Yashaswini Mittal, Head, Dan Bailey, (Emeritus), J.L. Denny, Jean E. Weber

Associate Professors Scott Emerson, A. Larry Wright

Assistant Professor Chengda Yang

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with major in statistics. Since statistics is an interdisciplinary field, students are encouraged to take courses in other areas. A student is expected to get a broad view of both theoretical and applied statistics.

To be admitted, an applicant must have completed the equivalent of an undergraduate degree in a quantitative field from a recognized institution, at least nine semester units of calculus and at least 6 semester units of upper division mathematics, and must carry a minimum grade point average of 3.00. Applicants are asked to submit scores on the Graduate Record Examination.

All graduate students are required to take 560a, 566a-566b, 551, 552, 548, 595 (at least two units), 597 (at least one unit), and 641. The Master's degree requires a minimum of 33 units. A Master's examination based on the first five of the required courses is offered every summer. A student must pass this exam within two years of admission.

To be admitted to the doctoral program, a student must pass the Master's examination at the Ph.D. qualifying level. The doctoral degree requires a minimum of 39 units beyond the requirements for the minor and dissertation. These 39 units must include all required courses for the Master's degree plus 667, 668 and MATH 563a or equivalent. A minimum of 18 units of dissertation credit is required.

Ph.D. candidates with other majors who wish to minor in Statistics are required to take 19 units of approved courses which must include 551, 552, 566a and 566b and at least one unit of 597.

Areas of specialty for the faculty include clinical trials, extreme value theory, image analysis, inference and probability.

574. Cleft Palate, Other Craniofacial Disorders, and Communication (3) II Communication disorders associated with cleft palate and other craniofacial defects. Speech assessment, evaluation and treatment; survey of dental and surgical services. P, 471L or 571. R/L.


576. Communicative Aspects of Aging (2) I Hearing, speech, voice, and language changes in the elderly caused by aging and disease. Emphasis on management of these problems. (Identical with CERO 576).


580. Community and Industrial Audiology (2) II Hearing conservation in industry, schools, and the community; auditory and non-auditory effects of noise, noise assessment, control, and protective procedures.


582. Hearing Disorders and Special Tests (3) II Pathologies of the hearing mechanism, and their auditory manifestations. Special audiologic procedures to differentiate site of lesion.


584. Audiologic Rehabilitation: Adults (3) II Speech reading; auditory training; problems encountered with amplification units; social, psychological, educational, speech, and language difficulties encountered by the hearing handicapped. P, 580, 483.

585. Audiologic Habilitation: Children (3) I Amplification, room acoustics, auditory and visual processing, evaluation and remedial programming for children with mild to moderate hearing impairment. P, 483 or 583.


600. Research Methods in Communication Sciences and Disorders (3) II Design and execution of descriptive and experimental research in communication sciences and disorders.

658a-658b. Advanced Clinical Studies: Speech-Language Pathology (1-3) I II R/P. 9 units. 1-5 With faculty consultation and supervision, students assume responsibility for all aspects of case management of children and adults. Exposure to clinical research methods and interdisciplinary staffings. 658a, b is in an extern setting. P, 558a or 558b.

659. Advanced Clinical Studies: Audiology (1-3) R/P. 9 units II 5 With faculty consultation and supervision, students assume responsibility for all aspects of case management of adults and children. Exposure to clinical research methods and interdisciplinary staffings. Open to majors only. P or CR, 559.


665R. Theoretical and Applied Statistics. Since statistics is an interdisciplinary field, students are encouraged to take courses in other areas. A student is expected to get a broad view of both theoretical and applied statistics.

Ph.D. candidates with other majors who wish to minor in Statistics are required to take 19 units of approved courses which must include 551, 552, 565a and 566b and at least one unit of 597.

Areas of specialty for the faculty include clinical trials, extreme value theory, image analysis, inference and probability.
motion pictures; basic problems faced by the professional actor seeking employment in these media; on camera experience with directed exercises and dramatic scenes. 2R, 3L, P, 151, audition.

595. Colloquium
a. Evaluation of Dance and Body Techniques (3) I (Identical with DNC 595a)
596. Seminar
d. * Dance-Related Art Forms (3) II 1994-95
(Identical with DNC 596d, which is home)
597. Workshop
a. * Technical Production (1-6) [Rpt./20 units] II S
b. * Costume Production (1-6) [Rpt./20 units] II S
c. * Lighting Production (1-6) [Rpt./20 units] II S
d. * Sound Production (1-6) [Rpt./20 units] I II S
e. * Scenic Production (1-6) [Rpt./20 units] I II S
f. * Performance (1-6) [Rpt./20 units] I II S
*May be convened with 400-level course.

600. Introduction to Graduate Study of Drama (3) I Methods and materials for research in theatre and drama; introduction to the bibliography of these fields; organization and form of thesis.


606. Advanced Voice and Movement for the Actor II (3) [Rpt./1] II Continued advanced study and exercise in voice and movement for the actor: standard stage speech, stage dialects, period customs, manners and movement. 65. P, audition.

609. Dramatic Criticism: Tragedy (3) I Comparative analysis of tragedy and theories of tragedy from antiquity to the present for stage and screen; writing of critical papers.

610. Dramatic Criticism: Comedy (3) II Comparative analysis of comedy and comic theory from antiquity to the present for stage and screen; writing of critical papers.

612. Advanced Studies in Theatre History (3) I II Concentrated study in theatre history, with major emphasis on the physical theatre, standard scholarly works, and source materials.

644. History of the American Theatre (3) II Studies in the American theatre and drama. Directed and individual projects will be assigned.


655. Advanced Directing I (3) I Techniques of stage directing, including play analysis, director-actor communication, director-designer communication, blocking, movement, composition; use of directorial style and the adaptation of directorial philosophies. 2R, 25.

656. Advanced Directing II (3) II Techniques of analyzing and staging classical texts for a contemporary audience; use of directorial style and the adaptation of directorial philosophies with an emphasis on staging the plays of Shakespeare. 2R, 25, P, 449, 655.


600. Introduction to Graduate Study of Drama (3) I Methods and materials for research in theatre and drama; introduction to the bibliography of these fields; organization and form of thesis.

606. Advanced Voice and Movement for the Actor II (3) [Rpt./1] II Continued advanced study and exercise in voice and movement for the actor: standard stage speech, stage dialects, period customs, manners and movement. 65. P, audition.

609. Dramatic Criticism: Tragedy (3) I Comparative analysis of tragedy and theories of tragedy from antiquity to the present for stage and screen; writing of critical papers.

610. Dramatic Criticism: Comedy (3) II Comparative analysis of comedy and comic theory from antiquity to the present for stage and screen; writing of critical papers.

644. History of the American Theatre (3) II Studies in the American theatre and drama. Directed and individual projects will be assigned.


655. Advanced Directing I (3) I Techniques of stage directing, including play analysis, director-actor communication, director-designer communication, blocking, movement, composition; use of directorial style and the adaptation of directorial philosophies. 2R, 25.

656. Advanced Directing II (3) II Techniques of analyzing and staging classical texts for a contemporary audience; use of directorial style and the adaptation of directorial philosophies with an emphasis on staging the plays of Shakespeare. 2R, 25, P, 449, 655.

**Students may earn a maximum of 9 units in T AR 696, with a maximum of 6 units in any one area.**

**Toxicology**
(See Pharmacology and Toxicology, College of Pharmacy)

**Veterinary Science (VSC)**
Pharmacy-Microbiology Building, Room 203
(602) 621-2355

Professors Charles R. Sterling, Head, Robert B. Chassion, Ed W. Cupp, Leonard W. Dewhirst (Emeritus), Lynn A. Joens, C. John Mare, Raymond E. Reed (Emeritus), James N. Shively (Emeritus), Norval A. Sinclair, J. Glenn Songer
Associate Professors Ronald W. Hilwig, Robert J. Jansen (Emeritus), Donald V. Lightner, David W. Sammons
Assistant Professor Michael W. Riggs

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees in pathobiology. The program offers an integrative approach to the basic animal and comparative health sciences with areas of study in immunology/pathology of disease; microbial pathogenesis; epidemiology, diagnosis and prevention of disease.

Applicants for admission shall hold an undergraduate or higher degree in the basic sciences. In addition to the application materials submitted to the Graduate College, applicants must submit to the department scores from the General Test of the Graduate Record Examination. The department recommends that scores in the advanced biology section be submitted if available. Foreign students must demonstrate English proficiency by earning a score of greater than 550 on the TOEFL or by completing two academic years or a baccalaureate degree at an institution where English is the medium of instruction, as prescribed by the Graduate College. The department requires that three letters of recommendation and a statement of intent, written by the applicant declaring career objectives and research experience be submitted.

**Master of Science:** Degree requirements include at least 30 units of graduate credit: 30 units of core courses in pathology, microbiology, immunology, biochemistry, and cell biology; 6 units of thesis; seminar units; an overall GPA of 3.0; an acceptable thesis; a manuscript in a form suitable for publication; and a final oral examination.

**Doctor of Philosophy:** Doctoral students must complete 69 units of graduate credit including the M.S. core, 36 units in the major area of dissertation. At least 6 semesters of essentially full-time graduate study is required with 30 units of graduate credit in the major field completed at the University of Arizona. Degree requirements of the student include passage of a doctoral preliminary examination, an acceptable dissertation, one or more manuscripts suitable for publication, and a doctoral oral defense.

**Minor:** At least one minor is required by the graduate college and may be chosen from any graduate program, including pathobiology, as approved by the graduate committee.

500a-500b. *Animal Anatomy and Physiology (3-3) Physiology, gross and comparative anatomy. 500a: Nervous, musculoskeletal, immune, hemolympathic, circulatory, and renal systems. 500b: Respiratory, digestive, endocrine, and reproductive systems. 500a is not prerequisite to 500b. P: ECOL 181, 182; CHEM 243a; MATH 117R/5.

503R. *Biology of Animal Parasites (3) I Biological relationships with emphasis on parasites of veterinary and human importance. Parasite morphology and physiology, life cycles, epidemiology, pathogenesis and zoonotic potential. P: 8 units of biology or microbiology. (Identical with ECOL 503R, ENTO 503R and MBIM 503R)

503L. *Parasitology Laboratory (1) I Parasite morphology and diagnostic laboratory techniques. P: 9 units of ecology or microbiology. CR, 503R. (Identical with ECOL 503L, ENTO 503L and MBIM 503L)
504.* Molecular Parasitology (3) II GRD The molecular details of parasites, cell biology and biochemistry of host and host cell interactions. P, 403R, BIOC 460/462a. (Identical with MBIM 504).

505.* Animal Diseases (3) I Survey of selected diseases of domestic animals.

519.* General Immunological Concepts (3) I (Identical with MBIM 519)

520.* Pathogenic Bacteriology (3) II (Identical with MBIM 520R)

523.* Mechanisms of Disease (4) II General pathology of animal and selected human diseases with emphasis on pathogenesis, pathophysiology, and morphologic changes at the macroscopic, microscopic and molecular levels. Recitation will stress general mechanisms of disease. Laboratory will reinforce recitation and stress recognition of disease in organs and tissues at the gross and microscopic levels. 3R, 1L. P, 400a -400b, 459 or CR, MIC 205, MIC 419 or equivalent or instructor approval. (Identical with MBIM 523 and TOX 523).

526.* Bio-Analytical Techniques (2) I 1993-94 (Identical with ENTO 526)

527.* Insect Chemical Ecology (2) I 1993-94 (Identical with ENTO 527)

538.* Ecology of Infectious Disease (3) II Ecology of the major infectious diseases of humans and other animals. P, 419 or 420. (Identical with MBIM 538)

543.* Research Animal Methods (3) I Regulations, care, diseases and techniques involving common laboratory animals used in research and teaching programs. (Identical with AN S 543, BIOC 543, MBIM 543)

549.* Diseases of Wildlife (3) II Important diseases of wildlife. Disease mechanisms, infectious agents, diagnostic procedures, and post-mortem techniques as well as a survey of selected but generally well-recognized diseases of wildlife. (Identical with WFSC 549)

550R.* Medical Mycology (2) II (Identical with MBIM 550R)

550L.* Medical Mycology Laboratory (2) II (Identical with MBIM 550L)

552.* Medical-Veterinary Entomology (4) I [Rpt./3] II (Identical with ENTO 552)

556.* Aquaculture (3) II 1991-92 (Identical with WFSC 556)

558.* Comparative Vertebrate Anatomy (4) I Evolution and gross structure of vertebrate organ systems. 2R, 6L. P, 8 units of animal biology. (Identical with ECOL 558)

559.* Comparative Vertebrate Histology (4) II Identification, phylogeny, and function of normal vertebrate tissues. 2R, 6L. P, 12 units of animal biology. A vertebrate anatomy and/or systematics course is strongly recommended. (Identical with ECOL 559)

565. Shrimp Pathology (3) [Rpt./1] S Comprehensive lectures and practical laboratory training on the current methods used to diagnose, prevent and treat the principal diseases of cultured penaeid shrimp. Field trip. Fee. P, B.S., M.S., and/or D.V.M. in biological and/or medically oriented fields.

601. Experimental Surgery (2) II 1993-94 Exercises in the surgical procedures commonly necessary in animal experimentation, including aseptic technique, anesthesiology, surgical operations, and care of the postsurgical patient. 1R, 3L. P, 3 units of mammalian anatomy.

612. Biological Electron Microscopy (4) I (Identical with MCB 612)

620. Experimental Methods for Research (4) II (Identical with MBIM 630)

649. Fishery-Water Quality and Toxicology (3) I (Identical with WFSC 649)

680. Pathophysiology (3) II Principles of systemic disease processes. Physical, chemical or cellular events which alter body functions or produce disease. P, 400a-400b/500a-500b, 405/505 and 423R/523R or equivalent.

**Water Resources**

See Hydrology and Water Resources

**Watershed Management**

(See Renewable Natural Resources)

**Wildlife and Fisheries Science**

(See Renewable Natural Resources)
Universities Libraries, Research and Service Facilities

Libraries

The University Library system contains almost 9,000,000 items, including books, periodicals, microforms, maps, government publications, manuscripts, and non-book media. Basic holdings cover all fields of instruction, and there are especially strong collections in anthropology, geology, arid lands, Spanish and Latin American language and literature, American agriculture, Southwestern American, Arizona, 20th century photography, history of science, science fiction, and 18th- and 19th-century British and American literature. Through the library the University is a member of the Center for Research Libraries and the Association of Research Libraries. The library is also a member of the AMIGOS Bibliographic Network and through that and other agencies can borrow materials for student and faculty research on interlibrary loan. The Library offers reference service, on-line searching of computerized databases, and bibliographic course-related instruction. The library is in the process of bringing up a Campus Information System called SABIO, which includes an on-line catalog.

The University Library system consists of the Main Library which houses the Central Reference Department, the Media Center, the Map Collection, the Current Periodicals and Reserve Book Room, and the Newspapers and Microforms Collection; the Science-Engineering Library; and the following Branch Collections; the Oriental Studies Collection, the Music Collection, the Center for Creative Photography, the Southwest Folklife Center, Special Collections and the Architecture Library. Three large but separate library facilities are the College of Law Library, the Arizona Health Sciences Library, and the Arizona State Museum Library. In addition, several other departmental libraries such as the Division of Economic and Business Research Library, the Steward Observatory Library, the Herbarium, and the Lunar and Planetary Services Library have been established to serve special research needs.

Central Reference—Houses the library's main card catalog and reference materials for the social sciences, fine arts and humanities.

Media Center—Houses all the library's non-book materials except microforms and music tapes and records. The Film department was added in 1988.

Map Collection—A depository for USGS maps, houses a fully cataloged collection of more than 200,000 maps on every subject.

Current Periodicals/Reserve Book Room—Displays current issues of the 5200-plus periodicals received in the Main Library, and manages the reading materials put on reserve for class use.

Newspapers and Microforms Collection—Displays current issues of the more than 150 newspapers to which the library has a collection of microforms which numbers nearly 2 million.

Science-Engineering Library—Houses all materials on science and technology; has more than 500,000 volumes, almost 1,500,000 microforms, and displays current issues of its 4,500-plus periodicals.

Music Library—Houses the library's collection of music-related books, periodicals, and indexes, as well as 50,000 scores, 15,000 pieces of sheet music and 25,000 recordings. Facilities for listening are provided.

Center for Creative Photography—Houses the library's archive of over 100 famous 20th century photographers. The Center's collections are internationally known.

Southwest Folklife Center—Houses musical tapes and manuscript archives of Southwest music and folklore.

Special Collections—Houses the library's collections of Arizoniana and Southwest Americana, special subject collections, rare books, fine printing, manuscripts, and The University of Arizona archives.

Oriental Studies Collection—Houses books, periodicals and newspapers in the Chinese, Japanese, Arabic, Persian, Turkish and other Oriental languages and has over 160,000 items.

Law Library—This library now contains more than 194,000 volumes, including the reported cases of all the jurisdictions in the United States and substantially all the English reported cases; American and English statutory law; decisions of federal administrative agencies; complete sets of leading legal periodicals; a carefully selected collection of legal encyclopedias, digests, treatises, and textbooks; and a developing collection of civil law with emphasis on Latin America.

The Health Sciences Library—This specialized library, which serves the University Hospital as well as the Colleges of Medicine, Nursing and Pharmacy. It contains over 170,000 cataloged volumes and receives approximately 3,600 serial titles. The collection includes books, journals, and nonprint materials in the health sciences.

Architecture Library—Houses a collection with emphasis on the topics of design, architectural history and theory, building technology, and desert architecture and design communications, including over 14,000 cataloged volumes, 120 periodicals and over 27,000 slides for architecture faculty use.

Research and Special Public Service Units

The following divisions are a part of or are affiliated with the University. Additional information regarding their organization and services may be obtained upon inquiry to the director concerned.

The Agricultural Experiment Station (1890), one of the divisions of the College of Agriculture, is responsible for the basic and applied research programs in the schools, departments, and other units within the College of Agriculture. It is administered by the Director of the Experiment Station. Modern facilities for laboratory and field research and extension, as well as graduate and undergraduate teaching, are available on the university campus and at agricultural centers throughout the state of Arizona, including the Santa Rita Experimental Range. Research is also conducted on farms, orchards, ranches, rangelands, and forests in cooperation with farmers, ranchers, and officials of various state and federal agencies.

The Arizona Arthritis Center (1977) is a multidisciplinary organization which is university-wide and contains physicians, basic scientists, allied health personnel and a variety of other health professionals interested in research, education and comprehensive care of pa-
tients with arthritis, rheumatic and related diseases. The center’s activities cover both basic and clinical research. Multiple programs in the area of basic mechanisms of disease in rheumatoid arthritis, systemic lupus erythematosus, metabolic bone disease, scleroderma, inflammatory muscle disease, spondyloarthropathies and various autoimmune diseases are actively being pursued.

There is a large clinical pharmacology study unit within the center. Basic work on the immunology of inflammatory cell function and the immunology of bone formation and destruction is being studied. There is a large area of research and the development of artificial joint prosthesis and biomaterials. Basic educational and health sciences research in rheumatic diseases are also carried on at the center.

Educational activities are carried on at the level of medical student, postgraduate trainees in primary care medicine, specialists in the area of orthopedics, rheumatology, joint replacement surgery as well as physical and occupational therapy and podiatry. There are extensive programs in patient education and postgraduate and continuing educational programs in the state, region and nation. The patient care model of interdisciplinary team care is emphasized. There are large programs in both adult and pediatric rheumatic disease care that provide for statewide consultative programs.

The Arizona Arthritis Center is a division of the College of Medicine reporting to the Dean of the College. This program, however, includes faculty and staff in the college as well as on main campus and is linked to staff and university physicians in University Physicians, Inc. and University Medical Center.

THE ARIZONA CANCER CENTER (1976) is a comprehensive cancer center officially designated by the National Cancer Institute. The center has as its mission to significantly contribute to research related to the understanding, diagnosis, treatment and prevention of cancer. To attain its goal, the Arizona Cancer Center pursues the following objectives:

1. Serve as a major geographic resource which is comprehensive in the scope of its activities
2. Promote excellence in basic and clinical cancer research, patient care and professional training and education
3. Facilitate and coordinate cancer-related programs at The University of Arizona
4. Develop an outreach program to serve the State of Arizona

The Arizona Cancer Center has been involved with planning educational, clinical and scientific activities. The center's commitments have included educational programs for medical and graduate students as well as teaching of practitioners and allied health professionals at local and national continuing medical education programs. Graduate degree programs in cancer biology were opened at The University of Arizona in 1988 with the support of faculty from the Arizona Cancer Center. Opportunities exist for medical students to work in cancer-related projects with faculty throughout the College of Medicine. The monthly Tumor Board at the Arizona Cancer Center is open to all interested persons and discusses aspects of cancer patient management and cancer prevention. As part of the required curricula of medical students, individual lectures in cancer education are presented in the Departments of Biochemistry, Molecular and Cellular Biology, Microbiology and Immunology, Anatomy, and Pharmacology.

The clinical oncology research programs of the Arizona Cancer Center have continued to draw an increasing cancer patient volume to the Arizona Health Sciences Center which is the leading resource for cancer care in the state.

Multidisciplinary cancer research expertise is continually developed and expanded in numerous clinical and laboratory programs that include basic research studies on oncogenes and on carcinogenesis; the study of heat, radiation, biological modifiers, bone marrow transplantation and drugs in cancer therapy; the interaction of vitamins A and E and their synthetic derivatives with pre-neoplastic and neoplastic states; the definition of the pathophysiology of clonal growth of human tumors; clinical pharmacology of anticancer drugs; tissue kinetics; tumor virology; cellular and molecular biology; medical imaging of cancer; tumor immunology; cancer prevention; cytogenetics; and clinical trials of promising approaches to cancer prevention, diagnosis and treatment.

ARIZONA CENTER FOR EDUCATIONAL EVALUATION AND MEASUREMENT (1980) initiates and conducts multidisciplinary research on such topics as nondiscriminatory psychological assessment; assessment of developmental competencies, sequencing of instruction, cognitive skills in children; and evaluation of school effectiveness. The center maintains state-of-the-art research technology, prepares graduate students in research methodology; and provides technical assistance to public and private agencies regarding testing, student services, curriculum development and systems for program evaluation.

THE ARIZONA CENTER ON AGING (1991) in The University of Arizona College of Medicine was formed as a merger of two units, The Arizona Long Term Care Gerontology Center and The Division of Restorative Medicine. The primary goals of the center are: 1) development of a more effective, humane and comprehensive system for delivering medical, health and social services to chronically ill elderly persons, 2) development of multidisciplinary education, clinical training programs involving college faculty, allied health professionals, university scientists and health administrators, and 3) engagement in research programs addressing the processes of aging and the delivery of services in the context of our society.

The center's activities are diverse and comprehensive. It has established a statewide network for education and research in gerontology/geriatrics. Maintenance of geriatric clinical settings including specialty clinics, a home visitation program, academic nursing home, a geriatric hospital unit and an inpatient consultation program within the College of Medicine offer for direct involvement of students from medicine, nursing, pharmacy and allied health professions in direct service experiences. Internships, postgraduate training in geriatrics, as well as an accredited geriatric fellowship in geriatrics are major features of the center program. Expanding research activities include investigations of basic mechanisms of the aging process, dementia, depression, falls, incontinence, environmental factors affecting aging and government policy, and delivery of quality services to older people and their families. All programs are designed to contribute to the increased well-being of the elderly.

THE ARIZONA CENTER FOR MATHEMATICAL SCIENCES (1988) provides an interdisciplinary environment for research and learning in the mathematical sciences. Its basic research themes are the modelling, understanding and applicability of nonlinear processes in optics, fluids, ocean waves, plasma physics, and neural networks with continuing investigations into pattern dynamics, chaos and turbulence, and in particular, their manifestation in optical contexts. The center supports graduate students, postdoctoral fellows, long- and short-term visitors and sponsors various workshops throughout the year. These activities serve to provide a rich environment for student and faculty interaction.
The Arizona Center for Mathematical Sciences (ACMS) received funding as a University Research Initiative of the Air Force Office of Scientific Research (AFOSR) for six years, 1986-1992, and is currently supported by continued funding from AFOSR as well as by funds from the National Science Foundation and the Office of Naval Research.

THE ARIZONA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT (1951) engages in graduate education, research, and extension. The unit is supported by The University of Arizona, the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute. The facilities and personnel of the unit are available to graduate students who wish to pursue both class work and research programs leading to advanced degrees in fisheries science and wildlife biology. The unit is housed in the School of Renewable Natural Resources.

THE ARIZONA COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT (1973), located in the School of Renewable Natural Resources, is engaged in research to support the natural science program of the National Park Service. In cooperation with The University of Arizona, the unit provides graduate research opportunities and instructional support in a broad array of natural resource problem areas.

THE ARIZONA EMERGENCY MEDICINE RESEARCH CENTER (1990) has established as its mission the enhancement and expansion of the research, education and training available within Arizona and the Southwest in emergency medicine. The center will focus on multidisciplinary studies in the area of out-of-hospital medical care available to the acutely ill and injured.

To complete its stated mission, the center has established specific goals related to the research of acute medical and traumatic injuries, evaluation of prehospital training programs and personnel requirements, and development of educational pathways for all levels of health care providers dedicated to careers in emergency medical systems.

To accomplish these goals the center consists of three operational divisions: Research, Education, Training.

Research: The mission of this division is to develop and implement research projects with a multidisciplinary focus. Emergency medicine draws upon various specialties in the course of patient care. The multidisciplinary focus of this division will attempt to draw together these specialties in efforts to improve patient survival in out-of-hospital emergency situations.

Education: Emergency Medical Services (EMS) began in the late 1960s in an effort to provide quality out-of-hospital care and treatment to a variety of patients under unusual circumstances. Until recently, these individuals have had limited access to a degree program related to EMS. The mission of this division is the formation of a bachelor's degree program in EMS and an advanced degree program in public administration.

Training: The mission of this division is to guide the development of standardized criteria to the paramedic level of Emergency Medical Technician (EMT) training and develop statewide outreach programs for currently certified EMTs, nurses and physicians.

THE ARIZONA INSTITUTE FOR NEUROGENIC COMMUNICATION DISORDERS (1986) is a multidisciplinary academic unit designed to promote, coordinate, and administer research programs and a clinical center for speech and language disorders caused by diseases of the nervous system. Initiated by the Department of Speech and Hearing Sciences and the Department of Neurology, this unit includes the participation of cognitive science, exercise and sport sciences, linguistics, neuroscience, pediatrics, physiology, psychology, radiology, surgery, and systems and industrial engineering. In addition to its major thrusts involving research programs and a clinical center, the institute's mission includes fostering editorial and postdoctoral educational state-of-the-art conferences, continuing education, and public service through advocacy for individuals with neurogenic communication disorders.

THE ARIZONA POISON AND DRUG INFORMATION CENTER (1980) is operated by the College of Pharmacy and is located in the Arizona Health Sciences Center Library. The center provides comprehensive poison and drug information and advice on treatment of poisoning to the public on a statewide basis. It also offers drug information and therapeutic consultations to health professionals. The center has a toll-free telephone number (1-800-362-0101) and can be reached 24 hours a day, seven days a week. Full-time clinical pharmacists staff the center and serve as poison and drug information specialists. Serving as consultants are medical toxicologists and specialists in plant and animal poisons, drugs, and environmental and industrial poisons. The Arizona Poison and Drug Information Center also provides for clinical training of pharmacy and medical students in the areas of clinical toxicology, drug and poison information. The Arizona Poison and Drug Information Center is a component of the Arizona Poison Control System which was established at The University of Arizona by the Arizona State Legislature in 1980. The Arizona Poison Control System is certified as a regional poison control program by the American Association of Poison Control Centers.

THE ARIZONA REMOTE SENSING CENTER (1972), located in the Office of Arid Lands Studies, serves as a focus of remote sensing research in the College of Agriculture. The staff of the center is involved in interdisciplinary remote sensing and computer mapping projects related to agriculture and natural resource management. The center contains equipment for manual analysis of satellite and aircraft imagery and computer systems for digital processing and display of images and maps. These facilities are available to faculty, students and operators from outside the University.

THE ARIZONA RESEARCH LABORATORIES (1979) is an interdisciplinary research unit established to provide a mechanism for administering and fostering research which is normally distributed among departments from more than one college unit. A major thrust of the organization is to form research groups to initiate new programs of high priority to the development of the educational and research mission of the University. The organization of the laboratories also provides a mechanism for serving as an organized research component for those teaching and research units that do not have such a capability.

The Arizona State Museum, founded as a territorial museum in 1893, is an educational, research, and service division of the University. Museum exhibits emphasize prehistoric and recent Indian cultures of Arizona and the Southwest. Special temporary exhibits on a variety of subjects are presented throughout the year. The museum is open daily to the public. Closed major holidays.

THE ARIZONA TRANSPORTATION AND TRAFFIC INSTITUTE (1959) is engaged in broad research aimed at developing advanced methods of analysis and obtaining answers to the transportation problems in Arizona. Topics considered include the planning, design, and operation of transportation facilities, including pavement design and highway materials, as well as maintenance of these systems. The institute acts as a technical information center, and its activities are closely
THE ARIZONA VETERINARY DIAGNOSTIC LABORATORY (1983) is a section of the Department of Veterinary Science, is supported by a combination of state funds and user fees. Services are provided for livestock and companion animal owners, wild species, and other animals supervised by federal, state, and municipal agencies, and include bacteriology, parasitology, virology, pathology, and microscopic water testing, and field investigations of range livestock problems referred by practicing veterinarians. Diagnostic faculty members participate in applied research studies involving disease problems of agricultural significance.

THE BOYCE THOMPSON SOUTHWESTERN ARBORETUM (1927) is operated cooperatively by The University of Arizona (College of Agriculture), Arizona State Parks Board, and the Boyce Thompson Southwestern Arboretum Board. This public botanical garden has facilities for teaching and research. Situated on the edge of the low desert near Superior, Arizona, the arboretum is a two-hour drive from the campus. Thirty acres of native and introduced plants from arid and semi-arid regions, together with about 1,000 additional acres of undisturbed fauna and flora, are under arboretum control. Additionally, large tracts of relatively undisturbed habitats in a variety of biomes lie in the surrounding Tonto National Forest. Laboratory facilities and housing are available. The arboretum is open daily except for Christmas Day.

THE BUREAU OF APPLIED RESEARCH IN ANTHROPOLOGY (1952), a division of the Department of Anthropology, is a regional and international center for basic and applied research relating to the resolution of critical problems in human society: culture change, urban and rural living, technological innovation, cross cultural and multicultural learning, health, disease and diet, ecological transformation, social and cultural impact assessment, agricultural and institutional development, educational innovation, and research methods. As part of the University, BARA promotes interdisciplinary research efforts. Also, BARA actively involves students of anthropology in its on-going research projects.

THE BUREAU OF MINERAL TECHNOLOGY (1915), formerly the Bureau of Geology and Mineral Technology, was reorganized by the state legislature, effective July 1, 1988, to form the Arizona Geological Survey as an independent state agency. The Arizona Geological Survey replaces the former Geologic Survey Branch of the bureau and continues to serve as the primary source of geologic information in the state.

The mission of the Mineral Technology Branch is maintained through the College of Engineering and Mines. Dissemination of information relating to mining, including health and mine safety and geological engineering, is accomplished by the Department of Mining and Geological Engineering. Information about mineral processing and extractive metallurgy can be obtained from the Department of Materials Science and Engineering.

THE CENTER FOR COMPUTING AND INFORMATION TECHNOLOGY (CCIT) (1985) provides campus-wide services in support of the instructional, research, and administrative computing needs of the University. The University's network of shared computers includes a VAXcluster comprised of two 3100s, and a 4000. Other mainframes include a Prime 6350, an IBM 3090-300E, and three CONVEX C240 minisupercomputers. CCIT also provides access to nearly 200 IBM PC, PC compatible, and Apple Macintosh microcomputers in labs available to faculty, staff, and students.

CCIT provides a campus-wide data communications network which supports both central and distributed processors. Access to facilities is available 24 hours a day. Additionally, CCIT provides access to external networks such as BITnet and the National Internet which provides access to academic institutions and supercomputer centers across the country. The University is a member of Cornell National Supercomputing Facility's Smart-Node Program and has a local allocation of service units.

Interactive access to CCIT's central computers comes through the IDX3000, or the campus ethernet (UANet) providing a campus-wide data communications network. Users may access these systems via terminal service centers at various campus locations. Remote access is also provided through the following dial-up numbers: 621-4141 and 621-9600.

CCIT offers many services to assist users in taking advantage of available computing resources. Services include mainframe and microcomputer access facilities; Computing and Technology Store (CATS) for microcomputers, workstations, peripherals, and software; Courseware Library for Instructional Computing (CLIC); a wide variety of training; consulting on the use of the University's computers and various microcomputers; communications and networking between user-owned equipment and the University's systems; computing facility planning and preparation; mainframe and microcomputer training facilities; programming and application support; dissemination of information through user publications, manuals, and program library documentation; and assistance in user acquisition of computing facilities.

The primary source for information and assistance on computing services and facilities is the CCIT Help Desk (621-HELP). The help desk is located in Room 218 of the Computer Center Building. Computer users can keep informed of changes in and additions to CCIT services by reading the Computing & Communications News.

THE CENTER FOR CREATIVE PHOTOGRAPHY (1975), a division of the University Library, is an internationally acclaimed research museum and study center devoted to the collections and archives of 20th-century photographers. Its collections include over 50,000 master prints, more than 500,000 study prints and negatives, correspondence, manuscripts, artifacts, and related documents. It contains a major research library of over 12,000 volumes and a rare book collection. The center sponsors a lecture series of internationally prominent photographers, historians, critics, and related scholars. The center has an extensive publishing program, which includes a journal entitled The Archive. This publication is a benefit of membership and is also available for purchase at the center's bookstore. Photographs and archive materials are available through both exhibition and personal print viewing appointments.

THE CENTER FOR ELECTRONIC PACKAGING RESEARCH (CEPR) (1991) performs research in the areas of electrical and thermal characteristics of electronic device packages and interconnected devices. The main activity is in modeling and simulation of electrical and thermal characteristics of Level 1 and Level 2 packaging, and experimental verification of the modeling results. The work in high-speed interconnect systems is being extended to on-chip interconnects. Faculty members from Electrical and Computer Engineering and Aerospace and Mechanical Engineering are currently contributing to CEPR projects.

The long-term goal of the Center for Electronic Packaging Research is to develop an integrated package and Multi-chip Module (MCM) design/simulation/manufacturing system. This system will
permit tradeoffs between performance, cost, reliability and manufacturability to be performed in the design phase. The simulation capability will assure first-pass achievement of packaging requirements, rather than require successive iterations. The CEPR is committed to expeditious transfer of basic research results to research sponsors, the electronic packaging community, and the USA, industry community, through reports, publications, workshops, education of students, and cooperative efforts which involve member industry personnel as both researchers and mentors.

THE CENTER FOR MICROCONTAMINATION CONTROL (1984) is located in the Department of Electrical and Computer Engineering. The center conducts fundamental and applied research that will lead to better control of defects in high density logic and memory technology. It is one of 45 centers throughout the country initiated by the National Science Foundation to increase the rate of technology interchange between the academic community and the scientists and engineers of industry. The center sponsors interdisciplinary research in more than six departments in several colleges. In addition, the center maintains a class-10 cleanroom, an equipment test-tower, and equipment for measuring low levels of airborne and surface contamination.

THE CENTER FOR MIDDLE EASTERN STUDIES (1975) is engaged in a variety of aspects of research on the modern Middle East. It is the headquarters for the University's Egypt Working Group, which promotes research by experts in several disciplines. Other areas of research include Afghanistan, Iran, Israel, North Africa, the Persian Gulf, and the Fertile Crescent. One of only thirteen federally funded Middle East centers in the country, this unit disseminates information about Middle East studies nationally and internationally. It also houses the Middle East Studies Association, which is the primary professional organization of scholars of the Middle East.

THE CENTER FOR PHARMACEUTICAL ECONOMICS (1989) is an interdisciplinary research and service unit of the College of Pharmacy. The center was established to provide national and international leadership in the application of the economic and administrative sciences in health care and pharmaceutical research, education, and service. The center integrates clinical and economic research to achieve a framework for the economic evaluation of new therapies. Services will include economic/economic analyses for individual client's needs; training programs for industry representatives, researchers, and practitioners; consultation on the design of studies to analyze cost and benefits of drugs; and the dissemination of information about pharmaceutical issues in managed care systems.

THE CENTER FOR THE MANAGEMENT OF INFORMATION (CMI) (1985), partially funded by grants from IBM, the National Science Foundation, the U.S. Army, and a consortium of industrial companies, supports interdisciplinary research in economic, political, social and technological aspects of information management. The M.B.A. curriculum parallels these research priorities and includes a series of integrated courses which assures that graduates are highly literate and sophisticated users/consumers of information management products. The center has many facilities which host classes and corporate groups as part of an extensive research program into a variety of group processes such as planning, problem-solving and decision making.

The Center for the Study of Complex Systems, a multidisciplinary unit bringing together local and external researchers, is designed to identify and explore new concepts and features of complex nonlinear systems in various areas of science. Recent advances in the understanding of fundamental aspects of nonlinear systems, coupled with progress in computer technology, permit new approaches to heretofore intractable scientific problems in diverse fields: climate; cognitive science; computational theory; elementary particle physics; evolutionary biology; materials and condensed matter science; motor control; robotics and prosthetics; neurobiology; vascular physiology; turbulence; and others. The center sponsors research, visiting scientists, workshops, and colloquia, all aimed at encouraging the development of new approaches to complexity at the interfaces between traditional scientific disciplines such as biology, chemistry, mathematics, and physics.

THE CENTER FOR THE STUDY OF HIGHER EDUCATION (1978) in the College of Education conducts research studies and provides related service activities to meet state and institutional needs, as well as those of national, international and regional governmental units and other organizations. It develops and disseminates information about higher education policy and operation and facilitates the research of faculty members and students. Special research and service projects are provided through university funds and outside support.

THE CENTER FOR TOXICOLOGY (1988) is an interdisciplinary organization that operates as a unit of the College of Pharmacy. Its mission is to strengthen and expand university and statewide efforts in toxicology. The goals of the center are to develop new research programs in toxicology, to insure that these and present programs have an interdisciplinary approach; to participate in graduate training at the master's, doctoral and postdoctoral levels; and to interact with local, state and federal agencies as well as with the private sector, to predict and prevent problems associated with exposure to toxic chemicals present in the home, workplace and environment. The underlying theme of the research activities of the center is elucidation of mechanisms by which chemicals produce adverse biological reactions.

THE COOPERATIVE EXTENSION SYSTEM (1914) brings information to interested people of Arizona. One of the three divisions of the College of Agriculture, it emphasizes agricultural production and natural resources, family and consumer resources, youth development (4-H), and community leadership and resource development. This informal education system is financed from federal, state, and county appropriations. It operates through the county extension agent, state and area specialist system with faculty trained in their specialty, and in the practical application of scientific information on farms, ranches and in rural and urban homes. Assistance is provided to target audiences in problem solving, information dissemination and educational programs.

THE DIVISION OF ECONOMIC AND BUSINESS RESEARCH (1949) is a research and service organization within the College of Business and Public Administration. Its broad objectives are to conduct research relating to business, economics, and public policy in Arizona; to complement the formal education of students with research experience; and to disseminate information. To achieve its objectives, DEBR builds and maintains regional economic models for applications in forecasting and impact simulation, conducts research on state and local market conditions, and analyzes the effects of public policy alternatives. It publishes the quarterly Arizona's Economy, the semi-annual chart book Arizona Economic Indicators, and the Arizona Statistical Abstract. It also produces forums and seminars for the public. In addition, DEBR answers requests from business, government, and the
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THE ARIZONA COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT (1973), located in the School of Renewable Natural Resources, is engaged in research to support the natural science program of the National Park Service. In cooperation with The University of Arizona, the unit provides graduate research opportunities and instructional support in a broad array of natural resource problem areas.

THE ARIZONA EMERGENCY MEDICINE RESEARCH CENTER (1990) has established as its mission the enhancement and expansion of the research, education, and training available within Arizona and the Southwest in emergency medicine. The center will focus on multidisciplinary studies in the area of out-of-hospital medical care available to the acutely ill and injured.

To complete its stated mission, the center has established specific goals related to the research of acute medical and traumatic injuries, evaluation of pre-hospital training programs and personnel requirements, and development of educational pathways for all levels of health care providers dedicated to careers in emergency medical systems.

To accomplish these goals the center consists of three operational divisions: Research, Education, Training.

Research: The mission of this division is to develop and implement research projects with a multidisciplinary focus. Emergency medicine draws upon various specialties in the course of patient care. The multidisciplinary focus of this division will attempt to draw together these specialties in efforts to improve patient survival in out-of-hospital emergency situations.

Education: Emergency Medical Services (EMS) began in the late 1960s in an effort to provide quality out-of-hospital care and treatment to a variety of patients under unusual circumstances. Until recently, these individuals have had limited access to a degree program related to EMS. The mission of this division is the formation of a bachelor's degree program in EMS and an advanced degree program in public administration.

Training: The mission of this division is to guide the development of standardized criteria to the paramedic level of Emergency Medical Technician (EMT) training and develop statewide outreach programs for currently certified EMTs, nurses and physicians.

THE ARIZONA INSTITUTE FOR NEUROGENIC COMMUNICATION DISORDERS (1986) is a multidisciplinary academic unit designed to promote, coordinate, and administer research programs and a clinical center for speech and language disorders caused by diseases of the nervous system. Initiated by the Department of Speech and Hearing Sciences and the Department of Neurology, this unit includes the participation of cognitive science, exercise and sport sciences, linguistics, neuroscience, pediatrics, physiology, psychology, radiology, surgery, and systems and industrial engineering. In addition to its major thrusts involving research programs and a clinical center, the institute's mission includes fostering doctoral and postdoctoral education, state-of-the-art conferences, continuing education, and public service through advocacy for individuals with neurogenic communication disorders.

THE ARIZONA POISON AND DRUG INFORMATION CENTER (1980) is operated by the College of Pharmacy and is located in the Arizona Health Sciences Center Library. The center provides comprehensive poison information and advice on treatment of poisoning to the public on a statewide basis. It also offers drug information and therapeutic consultations to health professionals. The center has a toll-free telephone number (1-800-362-0101) and can be reached 24 hours a day, seven days a week. Full-time clinical pharmacists staff the center and serve as poison and drug information specialists. Serving as consultants are medical toxicologists and specialists in plant and animal poisons, drugs, and environmental and industrial poisons. The Arizona Poison and Drug Information Center also provides for clinical training of pharmacy and medical students in the areas of clinical toxicology, drug and poison information. The Arizona Poison and Drug Information Center is a component of the Arizona Poison Control System which was established at The University of Arizona by the Arizona State Legislature in 1980. The Arizona Poison Control System is certified as a regional poison control program by the American Association of Poison Control Centers.

THE ARIZONA REMOTE SENSING CENTER (1972), located in the Office of Arid Lands Studies, serves as a focus of remote sensing research in the College of Agriculture. The staff of the center is involved in interdisciplinary remote sensing and computer mapping projects related to agriculture and natural resource management. The center contains equipment for manual analysis of satellite and aircraft imagery and computer systems for digital processing and display of images and maps. These facilities are available to faculty, students and cooperators from outside the University.

THE ARIZONA RESEARCH LABORATORIES (1979) is an interdisciplinary research unit established to provide a mechanism for administering and fostering research which bridges disciplines embraced by departments from more than one collegiate unit. A major thrust of the organization is to form research groups to initiate new programs of high priority to the development of the educational and research mission of the University. The organization of the laboratories also provides a mechanism for serving as an organized research component for those teaching and research units that do not have such a capability.

The Arizona State Museum, founded in 1893, is an educational, research, and service division of the University. Museum exhibits emphasize prehistoric and recent Indian cultures of Arizona and the Southwest. Special temporary exhibits on a variety of subjects are presented throughout the year. The museum is open daily to the public. Closed major holidays.

THE ARIZONA TRANSPORTATION AND TRAFFIC INSTITUTE (1959) is engaged in broad research aimed at developing advanced methods of analysis and obtaining answers to the transportation problems in Arizona. Topics considered include the planning, design, and operation of transportation facilities, including pavement design and highway materials, as well as maintenance of these systems. The institute acts as a technical information center, and its activities are closely
tied to those of the Department of Civil Engineering and Engineering Mechanics.

THE ARIZONA VETERINARY DIAGNOSTIC LABORATORY (1983) is a section of the Department of Veterinary Science, is supported by a combination of state funds and user fees. Services are provided for livestock and companion animal owners, wild species, and other animals supervised by federal, state, and municipal agencies, and include bacteriology, parasitology, virology, pathology and microbial water testing, and field investigations of range livestock problems referred by practicing veterinarians. Diagnostic faculty members participate in applied research studies involving disease problems of agricultural significance.

THE BOYCE THOMPSON SOUTHWESTERN ARBORETUM (1927) is operated cooperatively by The University of Arizona (College of Agriculture), Arizona State Parks Board, and the Boyce Thompson Southwestern Arboretum Board. This public botanic garden has facilities for teaching and research. Situated on the edge of the low desert near Superior, Arizona, the arboretum is a two-hour drive from the campus. Thirty acres of native and introduced plants from arid and semi-arid regions, together with about 1,000 additional acres of undisturbed fauna and flora, are under arboretum control. Additionally, large tracts of relatively undisturbed habitats in a variety of biomes lie in the surrounding Tonto National Forest. Laboratory facilities and housing are available. The arboretum is open daily except for Christmas Day.

THE BUREAU OF APPLIED RESEARCH IN ANTHROPOLOGY (1952), a division of the Department of Anthropology, is a regional and international center for basic and applied research relating to the resolution of critical problems in human society: culture change, urban and rural living, technological innovation, cross cultural and multicultural learning, health, disease and diet, ecological transformation, social and cultural impact assessment, agricultural and institutional development, educational innovation, and research methods. As part of the University, BARA promotes interdisciplinary research efforts. Also, BARA actively involves students of anthropology in its on-going research projects.

THE BUREAU OF MINERAL TECHNOLOGY (1915), formerly the Bureau of Geology and Mineral Technology, was reorganized by the state legislature, effective July 1, 1988, to form the Arizona Geological Survey as an independent state agency. The Arizona Geological Survey replaces the former Geologic Survey Branch of the bureau and continues to serve as the primary source of geologic information in the state.

The mission of the Mineral Technology Branch is maintained through the College of Engineering and Mines. Dissemination of information relating to mining, including health and mine safety and geological engineering, is accomplished by the Department of Mining and Geological Engineering. Information about mineral processing and extractive metallurgy can be obtained from the Department of Materials Science and Engineering.

THE CENTER FOR COMPUTING AND INFORMATION TECHNOLOGY (CCIT) (1985) provides campus-wide services in support of the instructional, research, and administrative computing needs of the University. The University’s network of shared computers includes a VAXcluster comprised of two 3100s, and a 4000. Other mainframes include a Prime 6350, an IBM 3090-300E, and three CONVEX C240 minisupercomputers. CCIT also provides access to nearly 200 IBM PC, PC compatible, and Apple Macintosh microcomputers in labs available to faculty, staff, and students.

CCIT provides a campus-wide data communications network which supports both central and distributed processors. Access to facilities is available 24 hours a day. Additionally, CCIT provides access to external networks such as BITnet and the National Internet which provides access to academic institutions and supercomputer centers across the country. The University is a member of Cornell National Supercomputing Facility’s Smart-Node Program and has a local allocation of service units.

Interactive access to CCIT’s central computers comes through the IDX-3000, or the campus ethernet (UANet) providing a campus-wide data communications network. Users may access these systems via terminal service centers at various campus locations. Remote access is also provided through the following dial-up numbers: 621-4141 and 621-9600.

CCIT offers many services to assist users in taking advantage of available computing resources. Services include mainframe and microcomputer open access facilities; Computing and Technology Store (CATS) for microcomputers, workstations, peripherals, and software; Courseware Library for Instructional Computing (CLIC); a wide variety of training; consulting on the use of the University’s computers and various microcomputers; communications and networking between user-owned equipment and the University’s systems; computing facility planning and preparation; mainframe and microcomputer training facilities; programming and applications support; dissemination of information through user publications, manuals, and program library documentation; and assistance in user acquisition of computing facilities.

The primary source for information and assistance on computing services and facilities is the CCIT Help Desk (621-HELP). The Help desk is located in Room 218 of the Computer Center Building. Computer users can keep informed of changes in and additions to CCIT services by reading the Computing & Communications News.

THE CENTER FOR ELECTRONIC PACKAGING RESEARCH (CEPR) (1991) performs research in the areas of electrical and thermal characteristics of electronic device packages and interconnected devices. The main activity is in modeling and simulation of electrical and thermal characteristics of Level 1 and Level 2 packaging, and experimental verification of the modeling results. The work in high-speed interconnect systems is being extended to on-chip interconnects. Faculty members from Electrical and Computer Engineering and Aerospace and Mechanical Engineering are currently contributing to CEPR projects.

The long-term goal of the Center for Electronic Packaging Research is to develop an integrated package and Multi-chip Module (MCM) design/simulation/manufacturing system. This system will
tied to those of the Department of Civil Engineering and Engineering Mechanics.

THE ARIZONA VETERINARY DIAGNOSTIC LABORATORY, (1983) a section of the Department of Veterinary Science, is supported by a combination of state funds and user fees. Services are provided for livestock and companion animal owners, wild species, and other animals supervised by federal, state, and municipal agencies, and include bacteriology, parasitology, virology, pathology, and microbial water testing, and field investigations of range livestock problems referred by practicing veterinarians. Diagnostic faculty members participate in applied research studies involving disease problems of agrcultural significance.

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THE CENTER FOR CREATIVE PHOTOGRAPHY (1975), a division of the University Library, is an internationally acclaimed research museum and study center devoted to the collections and archives of 20th-century photographers. Its collections include over 50,000 master prints, more than 500,000 study prints and negatives, correspondence, manuscripts, artifacts, and related documents. It contains a major research library of over 12,000 volumes and a rare book collection. The center sponsors a lecture series of internationally prominent photographers, historians, critics, and related scholars. The center has an extensive publishing program, which includes a journal entitled The Archive. This publication is a benefit of membership and is also available for purchase at the center's bookstore. Photographs and archival materials are available through both exhibition and personal print viewing appointments.

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The long-term goal of the Center for Electronic Packaging Research is to develop an integrated package and Multi-chip Module (MCM) design/simulation/manufacturing system. This system will
permit tradeoffs between performance, cost, reliability and manufacturability to be performed in the design phase. The simulation capability will assure first-pass achievement of packaging requirements, rather than require successive iterations. The CEPR is committed to expeditious transfer of basic research results to research sponsors, the electronic packaging community, and the U.S. industry community, through reports, publications, workshops, education of students, and cooperative efforts which involve member industry personnel as both researchers and mentors.

**THE CENTER FOR MICROCONTAMINATION CONTROL (1984)** is located in the Department of Electrical and Computer Engineering. The center conducts fundamental and applied research that will lead to better control of defects in high density logic and memory technology. It is one of 45 centers throughout the country initiated by the National Science Foundation to increase the rate of technology interchange between the academic community and the scientists and engineers of industry. The center sponsors interdisciplinary research in more than six departments in several colleges. In addition, the center maintains a class-10 cleanroom, an equipment test-tower, and equipment for measuring low levels of airborne and surface contamination.

**THE CENTER FOR MIDDLE EASTERN STUDIES (1975)** is engaged in a variety of aspects of research on the modern Middle East. It is the headquarters for the University’s Egypt Working Group, which promotes research by experts in several disciplines. Other areas of research include Afghanistan, Iran, Iraq, Israel, North Africa, the Persian Gulf, and the Fertile Crescent. One of only thirteen federally funded Middle East centers in the country, this unit disseminates information about Middle East studies nationally and internationally. It also houses the Middle East Studies Association, which is the primary professional organization of scholars of the Middle East.

**THE CENTER FOR PHARMACEUTICAL ECONOMICS (1989)** is an interdisciplinary research and service unit of the College of Pharmacy. The center was established to provide national and international leadership in the application of the economic and administrative sciences in health care and pharmaceutical research, education, and service. The center integrates clinical and economic research to achieve a framework for the economic evaluation of new therapies. Services will include economic/clinical analyses for individual client’s needs; training programs for industry representatives, researchers, and practitioners; consultation on the design of studies to analyze cost and benefits of drugs; and the dissemination of information about pharmaceutical issues in managed health care systems.

**THE CENTER FOR THE MANAGEMENT OF INFORMATION (CMI) (1985),** partially funded by grants from IBM, the National Science Foundation, the U.S. Army, and a consortium of industrial companies, supports interdepartmental research in economic, political, social and technological aspects of information management. The M.B.A. curriculum parallels these research priorities and includes a series of integrated courses which assures that graduates are highly literate and sophisticated users/consumers of information management products. The center has many facilities which host classes and corporate groups as part of an extensive research program into a variety of group processes such as planning, problem-solving and decision making.

The Center for the Study of Complex Systems, a multidisciplinary unit bringing together local and external researchers, is designed to identify and explore new concepts and features of complex nonlinear systems in various areas of science. Recent advances in the understanding of fundamental aspects of nonlinear systems, coupled with progress in computer technology, permit new approaches to heretofore intractable scientific problems in diverse fields: climate; cognitive science; computational theory; elementary particle physics; evolutionary biology; materials and condensed matter science; motor control; robotics and prosthetics; neurobiology; vascular physiology; turbulence; and others. The center sponsors research, visiting scientists, workshops, and colloquia, all aimed at encouraging the development of new approaches to complexity at the interfaces between traditional scientific disciplines such as biology, chemistry, mathematics, and physics.

**THE CENTER FOR THE STUDY OF HIGHER EDUCATION (1978)** in the College of Education conducts research studies and provides related service activities to meet state and institutional needs, as well as those of national, international and regional governmental units and other organizations. It develops and disseminates information about higher education policy and operation and facilitates the research of faculty members and students. Special research and service projects are provided through university funds and outside support.

**THE CENTER FOR TOXICOLOGY (1988)** is an interdisciplinary organization that operates as a unit of the College of Pharmacy. Its mission is to strengthen and expand university and statewide efforts in toxicology. The goals of the center are to develop new research programs in toxicology, to insure that these and present programs have an interdisciplinary approach; to participate in graduate training at the master’s, doctoral and postdoctoral levels; and to interact with local, state and federal agencies as well as with the private sector, to predict and prevent problems associated with exposure to toxic chemicals present in the home, workplace and environment. The underlying theme of the research activities of the center is elucidation of mechanisms by which chemicals produce adverse biological reactions.

**THE COOPERATIVE EXTENSION SYSTEM (1914)** brings information to interested people of Arizona. One of the three divisions of the College of Agriculture, it emphasizes agricultural production and natural resources, family and consumer resources, youth development (4-H), and community leadership and resource development. This informal education system is financed from federal, state, and county appropriations. It operates through the county extension agent, state and area specialist system with faculty trained in their specialty, and in the practical application of scientific information on farms, ranches and in rural and urban homes. Assistance is provided to target audiences in problem solving, information dissemination and educational programs.

**THE DIVISION OF ECONOMIC AND BUSINESS RESEARCH (1949)** is a research and service organization within the College of Business and Public Administration. Its broad objectives are to conduct research relating to business, economics, and public policy in Arizona; to complement the formal education of students with research experience; and to disseminate information. To achieve its objectives, DEBR builds and maintains regional economic models for applications in forecasting and impact simulation, conducts research on state and local market conditions, and analyzes the effects of public policy alternatives. It publishes the quarterly Arizona’s Economy, the semi-annual chart book Arizona Economic Indicators, and the Arizona Statistical Abstract. It also produces forums and seminars for the public. In addition, DEBR answers requests from business, government, and the
THE DIVISION OF NEUROBIOLOGY (1985) of the Arizona Research Laboratories is an interdisciplinary research unit devoted to the neurobiology and behavior of insects. Investigations under way in the division, probing experimentally favorable insect neural preparations at the cellular, developmental, molecular, and systems levels, seek to reveal fundamental neurobiological processes and mechanisms common to many animal species including human beings. These studies also promise to advance our understanding of agriculturally and medically harmful insects.

THE DIVISION OF SOCIAL PERSPECTIVES IN MEDICINE (1968) was established within the College of Medicine in recognition of the increasingly complicated cultural, social, economic, legal and ethical influences affecting the institution of medicine in American society. The efforts of this division are aimed at expanding and exciting the thinking of medical students and faculty in the area of human values and the role of medicine in contemporary society.

The activities of the division include symposia, seminars and workshops on such topics as cultural and economic factors in health and disease, ethical issues in medicine, medical jurisprudence, health needs of the elderly, care for the terminally ill, holistic medicine, innovations in medical education and other current issues. Local and national authorities are invited to participate in these programs from such fields as psychology, law, politics, sociology, anthropology, economics, theology and philosophy in addition to medicine.

THE ECONOMIC SCIENCE LABORATORY (1985) is a research unit of the College of Business and Public Administration. Its purpose is to support innovative research and instruction through the use of laboratory economics experiments. Recent areas of investigation include the performance of asset markets, comparative behavior of different auctions and forms of market organization, incentive systems in hierarchies, comparative evaluation of processes for the provision of public goods, and the design of new computer-assisted exchange institutions to meet the information and technological demands of a wide variety of environments. ESL operates two computer laboratories dedicated to conducting economic, political, and business and government policy experiments. Other programs include lectures by visiting scholars, seed money for faculty and graduate student research, and organization of internationally attended conferences.

THE ENGINEERING EXPERIMENT STATION (1941) administers the funds of sponsored grants and contracts of the faculty of the College of Engineering and Mines. Using state-appropriated funds, the station promotes, initiates, and conducts engineering research of potential benefit to the State of Arizona.

THE ENVIRONMENTAL RESEARCH LABORATORY (1967) conducts research in controlled-environment agriculture (CEA) and aquaculture for intensive food production, in seawater crop irrigation, biospherics, environmental control systems, and solar heating and cooling. ERL has designed CEA vegetable systems which produce crops in the desert sands of the United States, Mexico and the Middle East, and it has developed CEA for the intensive culture of marine shrimp. ERL is developing halophytic crops for livestock feeds and other uses—plants which are irrigated solely with seawater or other highly saline water. ERL consults on such special projects as the portrayal of agriculture of the future at the EPCOT Center at Walt Disney World in Florida. ERL has also developed a series of demonstration solar homes at Tucson International Airport, where the laboratory is located. The work in biospherics research is reflected in the development of Biosphere II, a private venture of Space Biosphere Ventures, and in global studies of the greenhouse effect.

FLANDRAU SCIENCE CENTER AND PLANETARIUM (1975), a part of the College of Arts and Sciences, was built as a result of a gift to the university by Grace H. Flandrau. It houses a 50-foot projection dome, a Minolta Series IV planetarium projector, and a hemispheric 35mm motion picture projector. It is used as a teaching facility for university classes in astronomy, and 25,000 Tucson public school children attend its special educational programs each year. The planetarium presents dramatic public programs on astronomy and general science that take audiences on cosmic journeys through time and space. The science exhibits halls and 16-inch telescope are open free to the public. Open daily except Mondays.

GRADUATE INTERDISCIPLINARY PROGRAMS. one of the major problems facing higher education is the initiation and development of effective interdisciplinary programs of education and research. The traditional disciplinary structure of the University is being altered in diverse ways, some involving informal cooperation of interested faculty, others resulting in creation of centers, institutes and other organized units. The University of Arizona has responded to these needs by creating a number of interdisciplinary units: the Office of Arid Lands Studies, the Environmental Research Laboratory, the Optical Sciences Center, the Institute for Atmospheric Physics, the Center for Insect Science, and others.

The Office of Graduate Interdisciplinary Programs was established as an agency responsible for furthering the development of new activities. The Director of Interdisciplinary Programs works with the Dean of the Graduate College and the Vice President for Research in fostering both educational and research projects.

THE INSTITUTE OF ATMOSPHERIC PHYSICS (1954) conducts research on fundamental aspects of climate and global change, mesoscale meteorology, atmospheric dynamics, radiative transfer, remote sensing, atmospheric aerosols, atmospheric chemistry, cloud and precipitation physics, lightning, and atmospheric electricity.

THE JEFFREY M. GOLDING CLINICAL RESEARCH UNIT (1984) is a specially equipped facility located in the College of Pharmacy. Its primary objective is to provide clinical scientists at The University of Arizona with the opportunity to study the action of drugs in humans with the ultimate goal of developing improved methods of treatment. The research unit has three rooms: a patient waiting room, a private office for conducting patient interviews or preliminary examinations, and the main room which houses two hospital beds and is equipped with specialized medical equipment.

THE KARL ELLER CENTER FOR THE STUDY OF THE PRIVATE MARKET ECONOMY (1983) is a research and education organization within the College of Business and Public Administration. It has three broad objectives: (1) to promote research in basic market processes, (2) to sponsor an Entrepreneurial Studies Program, and (3) to provide for business/academic exchange. Research is supported through the recruitment of Karl Eller Chair holders in the disciplines represented in the college. Faculty research fellowships are also available. The Entrepreneurial Studies Program offers both academic courses for students interested in entrepreneurship and practical courses on the development of busi-
ess plans. Approximately 50 students are included in the program annually.

**KUA8 COMMUNICATIONS GROUP** (1959) provides a wide range of instructional media, production, and public broadcasting services to the University, community and state. The division operates five maximum-power public broadcasting stations: KUA8-TV Channel 6; KUAS-TV Channel 27 (in the Catalina Foothills) and TV Translator K23CK, Duncan, Arizona; KUA8-FM (1550 kHz); KUA8-FM (90.5 MHz); KUAZ-FM (89.1 MHz) and Translator Frequencies, 897 MHz in northwest Tucson and Sierra Vista, 895 MHz in Phoenix and Duncan, Arizona. The stations are affiliated with the Public Broadcasting Service (PBS), National Public Radio (NPR) and American Public Radio (APR).

Professional production facilities are maintained in the Modern Languages Building and the Harvill Building. Production capability includes a color studio.

The Video Services department produces and distributes University of Arizona credit and noncredit courses to business and industry in the Tucson area through an 8-channel RTFS system called the Tucson Education Delivery System (TEDS), and across the nation by videotape and live satellite transmission. The University is a member of the National Technological University (NTU) consortium.

The Video Services department provides production and engineering support for the campus including: pre-production and post-production consultation, video production, television distribution nationwide via KU Band uplink facilities, locally through the TEDS system, microwave and ITFS transmission to Ft. Huachuca and Sierra Vista. The department also provides satellite reception and recording and a 2-way video teleconference origination facilities.

**THE LABORATORY OF TREE-RING RESEARCH** (1937) is an outgrowth of the pioneering tree-ring studies initiated by Andrew Ellicott Douglass at The University of Arizona in 1906. A division of the College of Arts and Sciences, the Laboratory conducts a unique program of teaching and research in all aspects of dendrochronology. Graduate-level instruction is offered through cooperating academic departments, and a limited number of graduate research assistantships are available to qualified students. Current research efforts are directed toward the quantification of tree-ring parameters, the establishment of new tree-ring chronologies throughout the world, the understanding of basic tree growth and environmental relationships, the reconstruction of paleohydrologic, paleoclimatic, and paleoeological variables, and the documentation and development of prehistoric chronological controls. Along with the world's largest collection of tree-ring specimens from living trees and ancient timbers, the laboratory maintains a variety of specialized equipment and data files containing processed tree-ring chronologies, relevant climatic and hydrologic records, and archaeological tree-ring dates and site information.

**THE LATIN AMERICAN AREA CENTER** (1974) is a unit of the Faculty of Social and Behavioral Sciences that fosters opportunities for students and researchers in Latin American Studies. In addition to offering undergraduate and graduate programs through its Committee on Latin American Studies, the center is a focal point of Latin American related research undertaken by scholars from every college of the University and whose interests range from medicine to law, from anthropology to ecology, from agriculture to history and from political science to international business. Each year the center engages in a variety of outreach activities: editing and publishing, television and radio programming, curriculum development for the public schools, conferences, lecture and film series, and government funded training programs for Latin American professionals. The center also works with students to arrange internship and study abroad programs designed to enhance career opportunities.

**THE LUNAR AND PLANETARY LABORATORY** (1960) is the research unit connected with the Department of Planetary Sciences. Planetary Sciences faculty also hold appointments in the laboratory, which, in addition, has a large research staff to conduct vigorous investigations which span a wide range of planetary and related astrophysical and space science. Laboratory staff participate closely in the graduate research instruction of the department. Close relationships and cooperative programs are maintained with a number of other units on the campus, including the departments of Astronomy, Geosciences, Optical Sciences, Physics, and the Steward Observatory.

Together, the Department of Planetary Sciences and the Lunar and Planetary Laboratory form an institute uncommonly broad and complete in its approach to planetary science education research. The department and laboratory participate in many NASA space science missions. Among the current missions in which the faculty are participating are the Voyager Mission, the Magellan Mission to Venus, the Galileo Mission to Jupiter, the Cassini/Huygens Mission to Saturn, the Mars-Observer Mission, the Russian Mars-94 Mission, and the Ulysses Heliospheric Explorer. In addition LPL scientists make use of Earth orbiting observatories, including the Hubble Space Telescope and the Ultraviolet Explorer. The Laboratory's Space Imaging Center contains one of the most extensive collections of planetary images in the world, beginning with those obtained from the earliest space projects and continuing to most current missions. LPL's Planetary Imaging Research Laboratory provides a comprehensive image processing facility for the analysis of planetary and astronomical data. Also available for student research are cosmochemistry and geochemistry laboratories, including a scanning electron microscope and microprobe facility, an experimental petrology laboratory, a radiochemistry separation and neutron activation laboratory, and a noble gas mass spectrometry laboratory. The numerous telescopes of the University of Arizona observatories are available for research projects, including instruments on Kitt Peak and in the Santa Catalina Mountains, as well as the Multiple Mirror Telescope on Mt. Hopkins; all are within easy reach of the University campus. Laboratory staff and students also make use of major observatories around the world, including the NASA Infrared Telescope Facility on Mauna Kea, Hawaii, and conduct a regular program of planetary, solar, and stellar infrared spectroscopy using the NASA Kuiper Airborne Observatory. The University is developing a new observatory site on Mt. Graham, northeast of Tucson. The laboratory participates in interdepartmental programs in theoretical astrophysics and in applied mathematics. The laboratory is housed in the Gerard P. Kuiper Space Sciences Building, with additional facilities in the Gould-Simpson Building.

**THE MEXICAN AMERICAN STUDIES AND RESEARCH CENTER** (1983) engages in research, publication, public service, and undergraduate and graduate educational activities which enhance the study of the Mexican American experience and related issues. Major objectives of interdisciplinary research and publication include such areas as expressive culture, adaptations of the Mexican-born into U.S. society, educational practices and policies, minority entre-
entrepreneurship, and health care behavior and intervention strategies. Special re-
search and service projects are provided through university funds and outside
support. Funds of sponsored grants support training of students in a variety of
disciplines. The center disseminates informa-
tion of concern to the Hispanic community, sponsors lectures and
forum provides assistance to and
linkage with the University and greater
Mexican American community, as well
as regional, national and international
private and public sectors.

THE MINERAL MUSEUM (1902) empha-
sizes Arizona’s unique mineral heritage in a spectacular collection of
minerals, fossils, and gems. The mu-
seum, a part of the collections of the De-
partment of Geosciences since its estab-
lishment, is open to students and the
general public.

THE OFFICE OF ARID LAND STUDIES (1964), administratively located within
the College of Agriculture, is active in international studies, natural resources
development and management, environ-
mental studies, economic botany, new
crop development, water and energy con-
servation, farming systems research,
information services, remote sensing,
geographic/information systems, pub-
lications and education. Activities are
conducted within the framework of the
arid environment. The office provides
interdisciplinary project management
and works closely with local and campus
communities as well as with local, state,
federal, and international government
agencies. The Graduate Interdisciplinary
Committee on Arid Lands Resource Sci-
ences offers programs leading to the
Doctor of Philosophy degree with a ma-
jor in arid lands resource sciences.

THE OPTICAL SCIENCES CENTER (1967) is a graduate center for research in
applied and theoretical optics. Areas in
which research is currently being con-
ducted include electro-optics, image for-
mation, image processing, infrared tech-
niques, laser physics, materials, medical
optics, nonlinear optics, optical bistali-
ity, optical design, optical fabrication
and testing, optical properties of
materials, pattern recognition, quantum
optics, remote sensing, spectroscopy,
surface physics, thin-film technology,
and X-ray optics. Interdisciplinary
programs in progress involve the depart-
ments of Applied Mathematics, Astron-
omy, Chemistry, Electrical and Compu-
ter Engineering, Physics, and Radiology,
as well as the Arizona Research Labora-
tory, the Optical Circuitry Cooperative
and the Optical Data Storage Center.

Special facilities of the Optical Scien-
ces Center include MBE, CVD and
vacuum-deposition thin-film facilities,
dark rooms, an electronics shop, in-
frared laboratory, instrument shop,
masse-optics shop, small-optics shop,
student/faculty shop, and shop.

THE RESPIRATORY SCIENCES CENTER (1975) has members from many
different academic departments. It is
responsible for interdisciplinary pul-
monary-allergy programs in research,
training and clinical services. It coor-
dinates activities of the Adult-Pediatric
Chest-Allergy Clinic as well as Univer-
sity Medical Center's Adult and Pediatric
Pulmonary Function Laboratories, Blood
Gas Laboratory and Respiratory Care
Service. It is also responsible for col-
laborative postdoctoral training programs
in Adult and Pediatric Pulmonary Medici-

A major function of the center is to
coordinate multidisciplinary research
programs in pulmonary disease with a
special emphasis on airways obstruc-
tive diseases (asthma, chronic bronchitis and
emphysema). It is responsible for the
Specialized Center of Research (SCOR)
in Airways Obstructive Diseases estab-
lished at the College of Medicine with
funding from the National Institutes of
Health. The center is widely known for
its epidemiologic studies, including a
longitudinal study of a representative
sample of the Tucson population (The
Tucson Epidemiologic Study of Airways
Obstructive Diseases), a longitudinal
study of newborns and their families
(The Children's Respiratory Study) and
studies of the health effects of environ-
mental pollution (The Health and
Environment Study). It is now very
involved in more basic research, par-
cularly in regard to the immunolog,
biochemical, pharmacological, neural,
and physiological mechanisms which af-
fect airway function and which may be
relevant to the pathogenesis of airways
obstructive diseases.

THE RUTH E. GOLDING CLINICAL
PHARMACOKINETICS LABORATORY
(1977) in the College of Pharmacy is pri-
marily an analytical laboratory where
new assays are developed to quantify
drugs and their metabolites from biolog-
ic fluids. These assays are used in con-
junction with animal and clinical re-
search projects to better define the
disposition of and response to drugs.
The results of these studies along with

the monitoring of drug plasma con-
centrations in patients are used to opti-
mize therapy by individualizing drug
administration.

SEMATECH CENTER OF EXCELLENCE FOR CONTAMINATION/DEFECT CON-
TROL AND ASSESSMENT (1988) is a
joint effort by industry and the federal
government to reverse a decline in U.S.
competitiveness in semiconductors, par-
particularly in the production of integrated
circuits. Centers of Excellence estab-
lished at universities represent SEMA-
TECH's external research arm and are
selected based on the quality and rele-
ance of the programs proposed. They
will bring graduate students into semi-

conductor manufacturing and will create
major academic manufacturing research
capability. In May 1988, the UA became
one of the first five universities selected
to become a center of excellence. Engi-
neers working in the center are develop-
ing methods for measuring and remov-
ing impurities, contamination, and
defects that are a major problem for
semiconductor manufacturing.

The Department of Electrical and
Computer Engineering, home to the
SEMATECH Center of Excellence, pro-
duces a director that coordinates the
efforts of principal investigators from
Electrical and Computer Engineering,
Materials Science and Engineering,
Chemical Engineering, and Systems
and Industrial Engineering. Part of the re-
search is being carried out with Sandia
National Laboratories in Albuquerque.

The technical objectives of the center are to (1) understand and utilize
developmental reactions and charge effects to
develop methods and systems for re-
moval of gaseous impurities and particu-
lars from process gases and liquids; (2)
to understand and develop control tech-
niques for contaminants and defects
originating from vacuum-related pro-
ces/equipment; and (3) to understand and develop test struc-
tures the role of spe-
cific contaminants in generating defects
that limit yield, and to prioritize efforts in
contamination/defect reduction. The
center transfers technology to
SEMATECH through reports, work-
shops, students, and cooperative re-
search projects.

THE SOCIAL AND BEHAVIORAL SCI-
ENCES RESEARCH INSTITUTE (1984)
supports and coordinates organized re-
search efforts within the Faculty of So-
cial and Behavioral Sciences. Through
a series of regular competitions, the
institute provides support for faculty
members and academic professionals
undertaking pilot projects or small-scale
studies likely to lead to externally-funded research. Support is also available for a small number of individuals to obtain release time from teaching in order to become Research Professors for a semester. The institute encourages both disciplinary and interdisciplinary research and takes initiatives to promote work in new areas of study. SBSRI contains two smaller units, the Data and Software Laboratory (DASL) and the Survey Research Center (SRC). DASL provides research support for faculty and their graduate students who are working on research problems requiring any form of data purchase and/or analysis, or who require word-processing support. SRC provides various forms of support for contract-based questionnaire delivery and analysis. SBSRI also liaises with other research units, SBS, including the Southwest Center. Annually, the institute sponsors a competition for the best research article published by a member of SBS.

THE SOUTHWEST CENTER (1982) is a unit of the Faculty of Social and Behavioral Sciences that fosters research, teaching, academic development, publication, and public programming on the history, culture, and development of the Greater Southwest (including northwestern Mexico). Southwest Center initiatives are designed for their multiplier effects on the research and service mission of the University, creating new opportunities for interdisciplinary scholarship. As an agency dedicated to the enhancement of regional scholarship and intellectual service, the Southwest Center acts as a liaison to funding sources; creates and implements interdisciplinary regional research projects; pursues a vigorous publishing program; and engages in a broad range of public outreach and programming: conferences, seminars, lectures, speakers' bureau, cultural events. The center publishes Journal of the Southwest, a scholarly regional quarterly, and sponsors the Southwest Center book series, with the UA Press as well as an imprint with the University of New Mexico Press.

THE SOUTHWEST INSTITUTE FOR RESEARCH ON WOMEN (SIROW) (1979) is a regional research and resource center within the Committee on Women's Studies. The institute develops and conducts research on women in the Southwest (Arizona, Colorado, New Mexico, and Utah) or of interest to scholars in the region. SIROW publishes a newsletter and a working paper series, links researchers with community organizations and policy makers through a research clearinghouse, and provides professional development and training for people in education, research, business, and government.

STEELE MEMORIAL CHILDREN'S RESEARCH CENTER (1986) represents a multidisciplinary and interdisciplinary approach to research related to various medical problems facing children. The goals of the center include:

1. Coordinate, focus, facilitate and increase research related to children's health
2. Foster multidisciplinary research on medical problems related to children
3. Expand research training and education programs, thereby facilitating the training of future researchers
4. Enhance the rapid application of research observations to patient care

Special emphasis will be placed on molecular genetics, immunology, neurology, gastroenterology and nutrition, behavioral sciences and developmental biology.

The center's research programs are closely tied to the educational and clinical activities of the Department of Pediatrics which include extensive outreach programs in numerous communities throughout the state, and general and subspecialty pediatric clinics and impartment services at University Medical Center, Tucson Medical Center and Kino Community Hospital.

THE STEWART OBSERVATORY (1916) was established by a generous gift from Lavinia Steward, in honor of her husband, George Steward. For many years, the observatory's principal telescope was its 36-in. (91-cm) reflector, constructed with the aid of the Steward bequest. Currently, the primary research telescopes of the observatory include the Multiple Mirror Telescope (MMT), located on the Mt. Hopkins summit in the Santa Rita Mountains, the 90-in. (2.3-m) reflector on Kitt Peak, and the 61-in. (1.55-m) reflector at the Mt. Bigelow station in the Santa Catalina Mountains. The MMT, operated jointly with the Smithsonian Astrophysical Observatory, represents an innovative and highly successful concept for construction of very large optical telescopes.

The observatory is constructing a major new telescope on Mt. Graham for work in the mm- and submm-wave region, in collaboration with the Max Planck Institute for Radio-astronomy in Bonn, West Germany. The Mirror Laboratory is developing optics for the next generation of giant optical/infrared telescopes. It will furnish the optics for an upgrade of the MMT, the Carnegie Foundation's Magellan Project (a 6.5-m telescope in Chile), and for the Columbus project, a collaboration of Steward Observatory with the Research Corporation, and other partners which will use two 84-m mirrors and be placed on Mt. Graham. Two construction efforts for space astronomy are also centered at the observatory: the Near Infrared Camera, which will be mounted in the Hubble Space Telescope to replace one of the existing instruments, and the Multiband Infrared Photometer, which is one of three instruments for the Space Infrared Telescope Facility, planned for launch early in the next century.

The offices and laboratories of the National Optical Astronomy Observatories are located across Cherry Avenue from Steward Observatory, and a division of the National Radio Astronomy Observatory occupies the top floor of the Steward Observatory building. The three observatories jointly sponsor a weekly series of professional colloquia. Steward Observatory also works closely with the Department of Planetary Sciences, the Optical Sciences Center, the Department of Physics, the Vatican Observatory, and the Flandrau Science Center and Planetarium, as well as with the astronomy departments of the other Arizona state universities.

UNIVERSITY ANIMAL CARE (1987) is the organization that provides services for care and use of all animals used for teaching and research at the University. The unit reports to the Office of the Vice President for Research.

The Animal Care Unit of the Arizona Health Sciences Center is located on the first floor of the Basic Sciences Building and houses all animals used by the Colleges of Medicine, Pharmacy and Nursing. The facility has held accreditation by the prestigious American Association for Accreditation of Laboratory Animal Care since 1969. Six veterinarians and a staff of trained laboratory animal tech-
nologists and technicians provide high quality animal care.

University Animal Care staff and faculty are available to train and assist investigators, research technicians and students on proper methods of animal handling and use. Expertise in the use of specific animal models is provided to investigators, thus eliminating unnecessary use of animals. A student manual for animal research is available by contacting the University Animal Care office (602)621-3454.

Federal and local policy requires that all research, teaching and/or testing protocols involving the use of animals must be reviewed and approved by the Institutional Animal Care and Use Committee. The IACUC as well as the staff of University Animal Care-AHSC is involved in the assurance that all laboratory animals receive humane treatment. Concern for the welfare of animals, plus recognition of the need for quality biomedical research and education are the primary objectives of University Animal Care.

THE UNIVERSITY HEART CENTER (1986) is an interdisciplinary organization to help prevent and cure heart and vascular disease through research, education, and patient care. Its eighty members with Ph.D.s, M.D.s, or both, are located throughout the campus, but hold joint conferences and are organized into research focus groups, and educational and patient care sections.

The University Heart Center operates as a division of the College of Medicine reporting to the Dean of the College. Its programs are linked to faculty and staff in the College, in University Medical Center, and in other colleges and units in the University.

THE UNIVERSITY OF ARIZONA MUSEUM OF ART (1942)—The University of Arizona is exceptionally fortunate in that it possesses several outstanding art collections. House in our modern building are the masterpieces of the Samuel H. Kress Collection, which include the surviving panels of the Relacro de Ciudad Rodrigo by Fernando Gallego and one of the finest university collections of Renaissance sixteenth - and seventeenth-century art in the United States. Contemporary international painting and sculpture are well represented in the Edward Joseph Gallagher III Memorial Collection; 61 sketches and models by Jacques Lipchitz which comprise one of the largest collections of his work in the world; the C. Leonard Pfeiffer Collection includes American paintings from the 1930s and was the first collection of art donated to the University. An active exhibition and educational program is available throughout the year. The Museum of Art is open to the public on weekdays from nine to five and on Sunday from noon to four. There is no admission fee.

THE UNIVERSITY OF ARIZONA PRESS (1959), a department of The University of Arizona, is a nonprofit publisher of scholarly and regional books. As a delegate of The University of Arizona to the larger world, the press publishes the work of scholars wherever they may be, concentrating upon scholarship that reflects the special strengths of The University of Arizona, Arizona State University, and Northern Arizona University.

The press publishes scholarly books in anthropology and archaeology, space sciences, Latin American studies, Native American studies, environmental studies, Western history, women's studies, and other fields. Also on the UA Press list are volumes of Native American and Chicano literature and trade books on the Southwest borderlands, including accounts by scholars and professional writers of the natural history, geography, history, folklore, and life-ways of the region. The UA Press does not publish children's books.

The University of Arizona Press invites inquiries from the authors of works—whether scholarly books or works of general interest—that are appropriate to its list.

Also appearing under the press imprint is the quarterly Journal of the Southwest, with separate editorial and subscription offices at the Southwest Center.

THE WATER RESOURCES RESEARCH CENTER (1965) is Arizona's state water resources research institute, established under the Water Resources Research Act of 1964 to promote and assist water-related research at the three state universities and enhance their contribution to the solution of critical water problems within the state. To accomplish this mission, the WRRC administers a federal water resources research grant program that provides funds for research on water-related issues. Research findings are brought to the attention of potential users and disseminated throughout the state. As Arizona's water information center, the WRRC provides access to water data and publications; produces informational directories and monographs, newsletters, and presentations; and sponsors conferences, symposia, and workshops. In addition, the center promotes and facilitates interdisciplinary research and carries out a policy analysis research program on water issues requiring examination from multidisciplinary perspectives.

Cooperating Organizations

Certain other independent agencies, not administratively a part of The University of Arizona, cooperate closely with the University and provide opportunity for study and research for faculty and qualified graduate students. Several of these are actually located on the University campus, and certain staff members of some also hold University staff appointments.

ARIZONA-SONORA DESERT MUSEUM is a self-supporting, nonprofit institution situated fourteen miles west of the city of Tucson in a saguaro and palo verde landscape of the Sonoran desert. This living indoor and outdoor museum of natural history enables one to gain in a few hours a knowledge of the flora and fauna of the Southwest that would otherwise require many years. Unique habitat groups and other displays of desert animals and plants have been developed at this unusual museum. The museum cooperates with educational institutions at all levels as an outdoor education center and provides laboratory and field space for research in the natural history of Arizona and Sonora, Mexico, with special emphasis on the Sonoran desert common to both states.

ARIZONA HISTORICAL SOCIETY. Organized in 1884 for "the collection and preservation of materials illustrative of the history of Arizona in particular and of the West generally," the Society receives support from the State, and maintains both a historical museum and a research library. The museum and library are located adjoining the University campus and contain 50,000 books, 2,000 manuscript collections, and 250,000 photographs, as well as film and oral history interviews. The manuscript collections are especially rich, with letters, diaries, journals, business records and other documents, many of which are still partially or completely unpublished. State and federal historical records are on microfilm, as are records from Spanish colonial archives. Membership is open to everyone. Museum collections of historical artifacts are available by appointment for study and research.

THE MUSEUM OF NORTHERN ARIZONA and its Research Center, located at Flagstaff, Arizona, provide unusually fine training and research facilities in many areas of anthropology, art, biological sciences, and geology. A close association is maintained between the staff
of the Museum and Research Center and certain teaching and research departments of The University of Arizona. Field work and independent research for a limited number of graduate students can be undertaken at the Museum's Research Center with the approval of the departments concerned, the Director of the Museum, and the Dean of the Graduate College. Registration may be arranged by the procedure commonly used for work done in absentia for credit in 900 Research to apply toward requirements for an advanced degree, for 910 Thesis, and for 920 Dissertation.

THE SOUTHWESTERN RESEARCH STATION of the American Museum of Natural History, New York, is located within a few hours of the University campus in the Chiricahua Mountains of southeastern Arizona. The station proper is located at an elevation of 5,400 feet in a moderate evergreen woodland climate, midway between the desert below and the coniferous forest above. A wide variety of life zones is represented within a few miles of the station between the desert floor and the fir-covered peaks at 9,800 feet. This unspoiled area within the Coronado National Forest includes many protected wilderness areas accessible only on foot or horseback.

Station living facilities and equipment are available, and the laboratory is well equipped for many kinds of modern field and laboratory research in ecology and physiology. The station is a field base for almost any kind of field work in biology, geology, paleontology, resource management, and wildlife management.

UNITED STATES GOVERNMENT AGENCIES. A number of agencies of the United States Government, including several divisions of the Agricultural Research Service and the Soil Conservation Service of the United States Department of Agriculture, the United States Bureau of Mines, and the United States Geological Survey, are located on or near the campus of the University. These research organizations work closely with the University, and a number of their personnel also hold university staff appointments.
ARIZONA BOARD OF REGENTS
Ex Officio
Ph.D., 1969, The Ohio State University
M.A., 1966, Ph.D., 1969, University of North Carolina
J. Gregory Falvey (1984), Associate Vice President for State Relations; B.A., 1968, Arizona State University; M.A., 1971, Princeton University.
Mary Jo Fox (1991), Assistant Vice President for Minority Student Affairs; B.S., 1968, Oklahoma State University; M.A., 1976, University of New Mexico; Ph.D., 1982, University of Arizona.
Charles A. Geoffrion (1987), Associate Vice President for Research; Director of Research Communications; B.A., 1965, Boston University.
Martha W. Gilliland (1990), Assistant Vice President for Research; B.A., 1966, Cawatha College; M.A., 1968, Rice University, Ph.D., 1973, University of Florida.
Robert W. Hacht (1991), Deputy Vice President for Facilities; B.S., 1961, University of Rhode Island; M.S., 1973, University of Florida.
Bert G. Landau (1985), Associate Vice President for Administration and Finance; Controller; B.A., 1966, Marshall University, M.B.A., 1974, University of Arizona.
Jerome A. Lucido (1984), Assistant Vice President for Enrollment Services; B.S., 1973, Miami University; M.Ed., 1981, Kent State University.
William R. Noyes (1968), Assistant Vice President for Student Relations; B.A., 1962, Stanford University; M.A., 1963, Fletcher School of Law & Diplomacy; Ph.D., 1968, University of California at Los Angeles.
Julius Parker (1989), Associate Vice President for Administrative Services; B.S., 1955, Prairie View A & M University; M.P.A., 1973, Shippensburg State University.
Albert B. Weaver (1958-83), Executive Vice President Emeritus; A.B., 1941, University of Montana; M.S., 1941, University of Idaho; Ph.D., 1952, University of Chicago.
Richard M. Edwards (1959-83), Vice President Emeritus for Student Development; B.S.Ch.E., 1941, Purdue University; M.S.Ch.E., 1948, University of Washington; Ph.D.Ch.E., 1964, E. Chem., 1974, University of Arizona.

Don A. Aripoli (1986), Associate Vice President for Student Affairs; A.B., 1967, Cornell College, M.S.Ed., 1969, Indiana University; Ph.D., 1977, University of North Carolina.
Herbert Dawson Rhodes (1943), Dean Emeritus of the Graduate College

Curtis Bradford Merritt (1949), Associate Dean Emeritus of the Graduate College

Deans
J. Lyle Bootman (1978), Dean, College of Pharmacy; B.S., 1974, University of Arizona; M.S., 1976, Ph.D., 1978, University of Minnesota.
Martha W. Gilliland (1990), Dean, Graduate College; B.A., 1966, Cawatha College; M.A., 1968, Rice University, Ph.D., 1973, University of Florida.
Robert L. Hull (1964), Dean Emeritus, College of Fine Arts; B.Mus., 1939, M.Mus., 1941, University of Rochester; Ph.D., 1945, Cornell University.
Luann L. Kragert (1987), Dean of Students; B.A., 1976, Midland Lutheran College; M.A., 1977, Ph.D., 1987, University of Nebraska.
Edgar J. McCullough, Jr. (1957), Dean, Faculty of Science, College of Arts and Sciences; A.B., 1953, M.S. 1955, West Virginia University; Ph.D., 1963, University of Arizona.
Darrel S. Metcalfe (1958-82), Dean Emeritus, College of Agriculture; B.S., 1960, University of Wisconsin; M.S., 1942, Kansas State College; Ph.D., 1950, Iowa State College.
F. Robert Paulsen (1964-86), Dean Emeritus, College of Education; B.S., 1947, Utah State University; M.S., 1949, Ed.D., 1966, University of Utah.
Herbert D. Rhodes (1943-77), Dean Emeritus, Graduate College; B.S., 1935; M.S., 1936, University of Arizona; Ph.D., 1939, University of Illinois.
Eugene V. Rutgers (1987), Dean, College of Agriculture; B.S., 1957, University of Minnesota; M.S., 1959, Ph.D., 1965, Cornell University.
Kenneth R. Smith (1980), Dean, College of Business and Public Administration; B.A., 1964, University of Washington; Ph.D., 1968, Northwestern University.
Gladyse E. Sorenson (1958-88), Dean Emerita, College of Nursing; B.S., 1945, University of Nebraska; M.S., 1951, University of Colorado; Ed.D., 1965, Columbia University.
David L. Windsor (1945-54), Dean Emeritus of Admissions and Records; B.A., 1943, M.A., 1951, University of Arizona.

Administrative Officers

(Year of first University appointment in parentheses after each name)
Manuel T. Pacheco (1991) President of the University; B.A., 1962, New Mexico Highlands University; M.A., 1966, Ph.D., 1969, The Ohio State University
Herbert E. Rhodes (1943) Dean Emeritus of the Graduate College

EX OFICIO
Governor of Arizona
C. Diane Bishop 
State Superintendent of Public Instruction

Appointed
Danny Siciliano
Donald Pett, J.D.
Esther N. Capen, M. Ed.
Andrew H. Hurwitz
Douglas J. Wall
Art Chapa, J.D.
Eddie Basha
John F. Munger, J.D.
Rhian Evans

January, 2000
January, 1994
January, 1994
January, 1976
January, 1994
January, 1998
January, 1998
January, 2000

Ph.D., 1976, Stanford University
M.A., 1965, Bowling Green State University; Ph.D., 1969 Ohio University

Graduate College Officers

Michael A. Cusanovich (1969), Associate Vice President for Research and Graduate Studies
Martha W. Gilliland (1990), Dean of the Graduate College
Herbert Dawson Rhodes (1943), Dean Emeritus of the Graduate College
Adela A. Allen (1968), Associate Dean of the Graduate College
Graduate Council

The Graduate Council consists of members representing all colleges of The University. The Council works with the Graduate College to review and establish policies affecting graduate education.

Adela A. Allen, Associate Dean of the Graduate College
Wilbur S. Ames, Professor of Teaching and Teacher Education
Diana B. Archangelii, Associate Professor of Linguistics
Randy L. Bassett, Associate Professor of Hydrology and Water Resources
Hermann Bleibtreu, Professor of Anthropology
Carrie Braden, Associate Professor of Nursing
Michael A. Cusanovich, Vice President for Research and Graduate Studies
Barry Garapol, Professor of Nuclear and Energy Engineering
Martha W. Gilliland, Dean of the Graduate College
Raphael P. Gruener, Director, Graduate Interdisciplinary Programs
James R. Halpert, Professor of Pharmacology and Toxicology
Steven D. Martinson, Professor of German
Jeanne M. McCarthy, Professor of Special Education and Rehabilitation
Fred S. Matter, Professor of Architecture
Eric A. Monke, Professor of Agricultural and Resource Economics
Jeanne E. Pemberton, Professor of Chemistry
Vincent Richardson, Professor of Teaching and Teacher Education
Karen L. Smith, Associate Professor of Spanish and Portuguese
Barbara Timmermann, Associate Professor of Arid Lands
Joseph T. Toller, Associate Professor Philosophy
Melanie Wallendorf, Associate Professor of Marketing
Stephen S. Willoughby, Professor of Mathematics
John M. Wilson, Professor of Dance

Committee on Graduate Study

Members of the Committee on Graduate Study represent the Dean of the Graduate College at all doctoral preliminary oral examinations and oral defense examinations and in the event of a second master’s oral examination. The Committee on Graduate Study representative certifies that these examinations are conducted in a manner consistent with the expectations and standards of the Graduate College.

(Date in parentheses after each name denotes expiration of term.)

Lawrence M. Aleamonii (1995), Professor of Education Psychology
Patricia L. Anders (1995), Associate Professor of Language, Reading and Culture
Jay B. Angeline ( ), Professor of Anatomy
Robert C. Angius (1994), Professor of Agricultural and Resource Economics
Shinrin Antila (1994), Associate Professor of Special Education and Rehabilitation
Nicholas Aquilano (1995), Associate Professor of Management Information Systems
Sorin H. Arnaehei (1995), Assistant Professor of Civil Engineering and Engineering Mechanics
Ronald G. Askin (1994), Professor of Systems and Industrial Engineering
Joseph J. Bahl (1995), Research Associate Professor of Internal Medicine
Boyd B. Baker (1995), Associate Professor of Exercise and Sport Sciences
H. Bradford Barber (1995), Research Associate Professor of Radiology
Michael Barfield (1994), Professor of Chemistry
William Barrett (1995), Professor of Accounting
Leo L. Barrow (1995), Professor of Spanish and Portuguese
Paul G. Bartels (1995), Professor of Plant Sciences
Stanley Bashkin (1995), Professor of Physics
Kathryn A. Bayles (1995), Associate Professor of Speech and Hearing Sciences
Lee Roy Beach (1995), Professor of Management and Policy
Victor M. Bernhard (1995), Professor of Surgery
Harris Bernstein (1994), Professor of Microbiology and Immunology
John H. Biegling (1995), Associate Professor of Astronomy
Dushar P. Birme II (1995), Associate Professor of Materials Science and Engineering
James Blanchard (1994), Professor of Pharmaceutical Sciences
Hermann Bleibtreu (1994), Professor of Anthropology
Hinrich L. Bohn (1994), Professor of Soil and Water Science
J. Fred Bozick (1994), Associate Professor Emeritus of Sociology
Candace S. Bos (1995), Associate Professor of Special Education and Rehabilitation
G. Tim Bowden (1995), Professor of Radiation Oncology, Pharmacology and Toxicology and Molecular and Cellular Biology
William S. Bowers (1994), Professor of Entomology
Michael D. Bradley (1994), Associate Professor of Hydrology and Water Resources
Charles J. Brainerd (1994), Professor of Educational Psychology
Patsy M. Brannon (1994), Professor of Nutrition and Food Science
Eldon L. Braun (1995), Professor of Physiology
Rubin Bressler (1995), Professor of Internal Medicine and of Pharmacology
John R. Brews (1994), Professor of Electrical and Computer Engineering
John T. Brobeck (1995), Associate Professor of Music
Danny L. Brower (1995), Associate Professor of Molecular and Cellular Biology and of Biochemistry
Megha Datta Brown (1994), Associate Professor of English
Merrie L. Brucks (1995), Associate Professor of Marketing
Mark L. Brusseau (1994), Assistant Professor of Soil and Water Resources
Curtis W. Bryant, Jr. (1995), Associate Professor of Civil Engineering and Engineering Mechanics
Nathan Buros (1994), Professor of Hydrology and Water Resources
Michael F. Burke (1995), Associate Professor of Chemistry
Ford N. Burkhardt (1995), Associate Professor of Journals
Janis M. Burt (1995), Associate Professor of Surgery and of Physiology
Henry C. Byerly (1994), Professor of Philosophy
Roger L. Caldwell (1994), Professor of Soil and Water Resources
Andreas Cangelaris (1995), Associate Professor of Electrical and Computer Engineering
Willard T. Carleton (1994), Professor of Finance and Real Estate
Dean W. Carter (1995), Professor of Pharmacology and Toxicology
Francois E. Cellier (1994), Associate Professor of Electrical and Computer Engineering
Dipaknar Chakravarti (1995), Professor of Marketing
Haihun Chen (1994), Assistant Professor of Management Information Systems
Robert W. Chiasson (1995), Professor of Veterinary Science
Peter J. Conley (1994), Professor of Geosciences
David A. Conn (1994), Associate Professor of Economics
Joseph L. Cowan (1994), Professor of Philosophy
David E. Cox (1994), Associate Professor of Agricultural Education
Clifton D. Crutchfield (1995), Assistant Professor of Higher Education
Andrew H. Cutler (1995), Assistant Research Professor in the Engineering Experiment Station
William J. Dallas (1995), Professor of Radiology and of Optical Sciences
Terry C. Daniel (1994), Professor of Psychology and of Renewable Natural Resources
Owen K. Davis (1995), Associate Professor of Geosciences
Thomas Davis (1994), Professor of Pharmacology
John M. Dean (1995), Professor in the Tree Ring Laboratory
Dominick Deluca (1994), Associate Professor of Microbiology and Immunology
Louis J. Demer (1994), Professor of Materials Science and Engineering
Sue K. Denise (1995), Associate Professor of Animal Sciences
Galina L. De Roeck (1995), Assistant Professor of Russian and Slavic Languages
Jerry R. Dickey (1995), Assistant Professor of Theatre Arts
Donald C. Dickinson (1995), Professor of Library and Information Science
Sarah M. Dinh (1994), Professor of Educational Psychology
Peter J. Downey (1995), Associate Professor of Computer Science
Dennis C. Doxtater (1994), Associate Professor of Architecture
Gordon R. Dutt (1994), Professor of Soil and Water Science
Richard M. Eaton (1994), Associate Professor of History
Nancy M. Eldredge (1995), Assistant Professor of Special Education and Rehabilitation
John H. Enemark (1995), Professor of Chemistry
Theoisa Eneman (1994), Assistant Professor of English
Robert P. Erickson (1995), Professor of Pediatrics and of Molecular and Cellular Biology
Thomas R. Ervin (1995), Professor of Music
Clemem D. Eskelson (1995), Research Professor of Surgery
Lawrence J. Evers (1995), Professor of English
Lewbery L. Ewbank (1995), Professor of Communication
Kenneth A. Feldmann (1995), Associate Professor of Plant Sciences
William R. Ferrell (1994), Professor of Systems and Industrial Engineering
Aurelio G. Figueredo (1994), Assistant Professor of Psychology
Daniel J. Flannery (1995), Assistant Professor of Family and Consumer Resources
Karl W. Flessa (1994), Professor of Geosciences
Roger W. Fox (1994), Professor of Agricultural and Resource Economics
Edward D. French (1994), Associate Professor of Mathematics
Richard L. Friedman (1995), Associate Professor Microbiology and Immunology
K. Fung (1995), Associate Professor of Aerospace and Mechanical Engineering
Lynn Galbraith (1994), Assistant Professor of Art
Adel S. Gamal (1994), Professor of Near Eastern Studies
Rose M. Gerber (1994), Associate Professor of Nursing
Robert Giebner (1994), Professor of Architecture
Charles E. Glass (1995), Associate Professor of Mining and Geological Engineering
Richard S. Glass (1994), Professor of Chemistry
Yetta M. Goodman (1995), Professor of Language, Reading and Culture
Ellery C. Green (1995), Professor of Architecture
W. Dwaine Greer (1995), Professor of Art
William F. Greer (1995), Associate Professor of Journalism
Gary A. Griffin (1994), Professor of Teaching and Teacher Education
Lakshman Guruswamy (1995), Associate Professor of Law
Henry H. Hagedorn (1994), Professor of Entomology
Marilyn J. Halonen (1995), Professor of Pharmacy
James R. Halpert (1994), Professor of Pharmacology
Robert L. Hamblin (1995), Professor of Sociology
Michael Hammond (1994), Associate Professor of Linguistics
Regents' Professors

Angel, J. Roger P. (1973), Regents' Professor and Professor of Astronomy, and Optical Sciences; A.B., 1950, University of California at Los Angeles; B.S., 1951, Massachusetts Institute of Technology; M.S., 1954, Stanford University.


Bernays, Elizabeth A. (1989), Head of the Department of Entomology; Regents' Professor and Professor of Entomology; B.Sc., 1948, Ph.D., 1950, Massachusetts Institute of Technology.

Binkley, Donald A. (1960), Head of the Division of Biological Sciences; Regents' Professor and Professor of Geosciences, Planetary Sciences, and in the Lunar and Planetary Laboratory; B.S., 1946, Rensselaer Poly Institute; Ph.D., 1950, University of California at Berkeley.

Birge, Charles W. (1928), Regents' Professor and Professor of Chemistry; A.B., 1955, Yale University; A.M., 1957, University of Chicago; Ph.D., 1960, Harvard University.

Borowitz, George S. (1977), Regents' Professor and Professor of Electrical and Computer Engineering; B.S., 1964, University of California at Berkeley; Ph.D., 1969, Stanford University.

Brown, Douglas H. (1984), Regents' Professor and Professor of Chemistry; A.B., 1958, University of California at Berkeley; Ph.D., 1960, Stanford University.

Buccellati, Edward J. (1970), Regents' Professor and Professor of Psychology; A.B., 1944, University of California at Berkeley; Ph.D., 1959, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

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Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.

Burke, Ralph M. (1979), Regents' Professor and Professor of Sociology; A.B., 1954, University of California at Berkeley; Ph.D., 1960, University of California at Berkeley.
Teaching and Research Faculty

This list identifies tenured and tenure-track faculty members appointed for the 1992-93 academic year, as well as emeritus faculty. For a list which includes all faculty appointed for the 1992-93 academic year, including their dates of appointment and degrees, consult The University of Arizona General Catalog.
Beck, Jonathan, Professor of French and Italian
Beck, L. Susan, Assistant Professor of Geosciences
Becker, Judith V., Professor of Psychiatry and of Psychology
Becker, Stewart, Professor Emeritus of Electrical Engineering
Bedford, Felice L., Assistant Professor of Psychology
Beeker, Ruth Ann, Associate Professor of Teaching and Teacher Education
Beigel, Allan, Professor of Psychiatry and of Psychology
Bell, Iris R., Assistant Professor of Psychiatry and of Psychology
Benjamin, James B., Associate Professor of Surgery
Benson, Bryant, Professor of Anatomy
Benson, Clark T., Professor of Mathematics
Benz, Willy, Associate Professor of Astronomy, Arizona Research Laboratories, and Steward Observatory
Bergan, John R., Professor of Educational Psychology
Bergesen, Albert J., Professor of Sociology
Berkhout, Carl T., Associate Professor of English
Bernard, Rosemary T., Associate Professor of Art
Bernard, Peter B., Associate Professor of Chemistry
Bernays, Elizabeth A., Professor of Entomology
Bernhard, Victor M., Professor of Surgery
Bernstein, Alan E., Associate Professor of History
Bennett, Gail L., Professor of History
Bernstein, Harris, Professor of Microbiology and Immunology
Berry, James W., Professor Emeritus of Nutrition and Food Science
Berry, Laura C., Assistant Professor of English
Bessey, Paul M., Associate Professor Emeritus of Plant Sciences
Bettendorf, Eric A., Assistant Professor of Atmospheric Physics, and in the Institute of Atmospheric Sciences
Bickel, William S., Professor of Physics
Biegling, John H., Associate Professor of Astronomy
Bier, Milan, Professor of Engineering and of Microbiology
Bigi, Brunella, Assistant Professor of French and Italian
Binnie, Dunbar P., III, Associate Professor of Materials Science and Engineering
Bishop, Jerold, Associate Professor of Art
Black, John H., Professor of Astronomy
Blanchard, James, Professor of Pharmaceutical Sciences
Blaik, David E., Professor of Anatomy
Blecha, Milo K., Professor Emeritus of Elementary Education
Bleck, Erich K., Associate Professor Emeritus of Finance and Real Estate
Bleche, Hermann K., Professor of Anthropology
Blitzner, Leon, Professor Emeritus of Physics
Block, Michael K., Professor of Economics
Bloom, John H., Professor Emeritus of Music
Bloom, John W., Professor of Internal Medicine
Bloom, Paul, Assistant Professor of Psychology and of Linguistics
Blos, Homer E., Associate Professor Emeritus of Plant Pathology
Boe, John M., Professor of Music
Boeils, Jackson G., Associate Professor of Art
Bogart, Fred O., Professor Emeritus of Accounting
Buhn, Hinrich L., Professor of Soil and Water Science
Bohnert, Hans J., Professor of Biochemistry; Associate Professor of Molecular and Cellular Biology and of Plant Sciences
Bonsignore, Michael T., Professor of Near Eastern Studies and of Geography and Regional Development
Bonnard-Lord, Dominique, Assistant Professor of Architecture
Boone, Daniel R., Professor Emeritus of Speech and Hearing Sciences
Bootman, J. Lyle, Professor of Pharmacy Practice
Boozer, Richard R., Professor of Psychology and of Psychiatry
Borhek, James T., Associate Professor of Sociology
Bos, Candace S., Professor of Special Education and Rehabilitation
Bottacini, Manfred R., Professor Emeritus of Aerospace and Mechanical Engineering
Bourque, Don P., Professor of Biochemistry and of Molecular Cellular Biology
Bowden, George T., Professor of Radiation Oncology, Pharmacology and Toxicology, and Molecular and Cellular Biology
Bowen, Don L., Professor Emeritus of Management Policy
Bowen, Roger, Associate Professor of English
Bowen, Theodore, Professor of Physics and of Radiology
Bowers, Raymond V., Professor Emeritus of Sociology
Bowiers, William S., Professor of Entomology
Boyden, Thomas W., Associate Professor of Internal Medicine
Boyer, John T., Professor of Internal Medicine and of Family and Community Medicine
Boynton, William V., Professor of Planetary Sciences, and in the Lunar and Planetary Laboratory
Boyes, Edward A., Professor of Microbiology and Immunology
Braden, Carrie J., Associate Professor of Nursing
Bradley, John M., Associate Professor of Language, Literature, and Culture
Bradley, Michael D., Associate Professor of Hydrology and Water Resources
Brainerd, Charles J., Professor of Educational Psychology
Brann, Patsy M., Professor of Nutrition and Food Science
Braun, Eldon J., Professor of Physiology
Breidel, Klaus, Professor of Pharmacology
Breiner, Robin J., Associate Professor of Finance and Real Estate
Bressler, Robin, Professor of Internal Medicine and of Pharmacology
Brettal, Eleanor V., Professor Emerita of Nursing
Brow, John R., Professor of Electrical and Computer Engineering
Briggs, Maurice M., Professor Emeritus of Finance, Insurance and Real Estate
Briggs, Robert E., Professor Emeritus of Plant Sciences
Brillhart, John D., Professor of Mathematics
Brio, Moysey, Assistant Professor of Mathematics
Broadfoot, A. Lyle, Senior Research Scientist in the Lunar and Planetary Laboratory
Brobeck, John T., Assistant Professor of Music
Bronfman, Corinne M., Associate Professor of Finance and Real Estate
Bronstein, Judith, Assistant Professor of Ecology and Evolutionary Biology
Brosin, Henry W., Professor of Psychiatry
Browder, Robert P., Professor Emeritus of History
Brower, Danny L., Associate Professor of Molecular and Cellular Biology and of Biochemistry
Brown, A. Dolores, Professor Emerita of Spanish and Portuguese
Brown, Burnell R., Professor of Anesthesiology and of Pharmacology
Brown, Edward D., Professor Emeritus of Elementary Education
Brown, Edward G., Associate Professor of French and Italian
Brown, Meg L., Assistant Professor of English
Brown, Michael F., Professor of Chemistry and of Biochemistry
Brown, William H., Professor of Animal Sciences
Brown, Samuel R., Professor Emeritus of Systems Laboratory
Brucks, Merle J., Associate Professor of Marketing
Brusseau, Mark L., Assistant Professor of Soil and Water Science
Bryant, Curtis W., Associate Professor of Civil Engineering, Engineering Mechanics and of Chemical Engineering
Buchanan, Allen E., Professor of Philosophy
Buchanan, Paul G., Assistant Professor of Political Science
Buchholzer, Andrew W., Professor Emeritus of Music
Buchmann, Stephen L., Adjunct Associate Professor of Entomology
Buckman, Carl J., Professor Emeritus of Civil Engineering
Buckner, Steven W., Assistant Professor of Chemistry
Budd, John M., Assistant Professor of Library Science
Budhu, Muniram, Associate Professor of Civil Engineering and Engineering Mechanics
Buehler, John E., Professor Emeritus of Economics
Bull, William B., Professor of Geosciences
Buller, David B., Associate Professor of Communication
Buras, Nathan, Professor of Hydrology and Water Resources
Burd, Gail D., Associate Professor of Anatomy and of Molecular and Cellular Biology
Burgon, H. Michael, Professor of Communication
Burgon, Judee K., Professor of Communication
Burke, James J., Professor of Optical Sciences
Burke, Michael F., Associate Professor of Chemistry
Burke, Lloyd E., Professor Emeritus of Geophysics
Burkhard, Ford N., Associate Professor of Journalism
Burkhardt, Leland, Professor Emeritus of Horticulture and of Landscape Architecture
Burns, Lawton R., Associate Professor of Management Policy, and in the School of Public Administration and Policy
Burns, Robert A., Associate Professor of Religious Studies
Burns, Robert C., Professor Emeritus of Drama
Burrows, Adam, Professor of Physics, in the Arizona Research Laboratories, and in Astronomy
Burrows, Benjamin, Professor of Internal Medicine
Burton, Janice M., Associate Professor of Physiology
Burton, Lloyd E., Professor Emeritus of Addiction Studies and of Pharmacy Practice
Butler, Henry E., Jr., Professor Emeritus of Educational Foundations and Administration
Butler, Robert E., Professor of Geosciences and in the Arizona Research Laboratories
Butman, Samuel M., Associate Professor of Internal Medicine
Byerly, Henry C., Professor of Philosophy
Byers, James M., III, Associate Professor of Pathology
Byrne, David N., Associate Research Scientist and Associate Specialist in Entomology
Callen, Curtis, Jr., Professor Emeritus of Agricultural Economics
Calder, William A., Professor of Ecology and Evolutionary Biology
Caldwell, Mary E., Professor Emeritus of Bacteriology and of Pharmacology
Caldwell, Roger L., Professor of Soil and Water Science
Call, Reginald L., Associate Professor Emeritus of Electrical and Computer Engineering
Calmes, Robert E., Professor Emeritus of Educational Psychology
Calvert, Paul D., Professor of Materials Science and Engineering
Campbell, John D., Assistant Professor of History
Campbell, Sammy C., Associate Professor of Internal Medicine
Campos-Outcalt, Douglas E., Assistant Professor of Family and Community Medicine
Canfield, Louise M., Professor of English
Canfield, J. Douglas, Professor of English
Canfield, J. Douglas, Professor of English
Canfield, Louise M., Associate Professor of Biochemistry and of Family and Community Medicine
Campell, Andreas, Associate Professor of Electrical and Computer Engineering
Cannon, Moody Dale, Associate Professor Emeritus of Soils, Water and Engineering
Capp, Michael P., Professor of Radiology
Carney, Willard T., Professor of Finance and Real Estate
Carlile, Robert W., Professor Emeritus of Electrical and Computer Engineering
Camody, Raymond F., Associate Professor of Radiology
Logan, Joy L., Associate Professor of Internal Medicine

Lohman, Timothy G., Professor of Exercise and Sport Sciences

Lomen, David O., Professor of Mathematics

Lomont, John S., Professor Emeritus of Mathematics

Long, Alan, Professor of Geosciences and of Hydrology and Water Resources

Longacre, William A., Professor of Anthropology

Longman, Alice J., Professor of Nursing

Lea, John H., Assistant Professor of Family and Consumer Resources

Lopes, Vicente L., Assistant Professor of Watershed Management

Lord, William B., Professor of Agricultural Economics and of Hydrology and Water Resources

Louri, Ahmed, Assistant Professor of Electrical and Computer Engineering

Lovecchio, David, Professor of Mathematics

Ludin, Les H., Professor of Ecology and Evolutionary Biology

Lowell, Alice B., Professor Emerita of Home Economics

Ludovici, Peter P., Professor Emeritus of Microbiology

Lunine, Jonathan I., Associate Professor of Planetary Sciences, Lunar and Planetary Laboratory, and Arid Lands Studies

Lutz, Wendell R., Assistant Professor of Aerospace and Mechanical Engineering

Lux, Babette, Associate Professor Emerita of German

Lynn, David C., Professor of Materials Science and Engineering

Lynch, Lilian, Associate Professor Emerita of Nursing

Lynch, Ronald M., Assistant Professor of Physiology and of Pharmacology

Lynn, Edward S., Professor Emeritus of Accounting

Lynn, Klonda, Professor Emerita of Speech

Lynn, Mary R., Assistant Professor of Nursing

Lyons, Lynn K., Assistant Professor of Family and Consumer Resources

Lytle, Clifford M., Professor of Political Science

MacCormac, Patricia, Associate Professor of Sociology

MacDonald, Deborah J., Associate Professor of Marketing

Mack, Julie A., Assistant Professor of Theatre Arts

MacKenzie, Neil E., Associate Professor of Pharmaceutical Sciences and of Biochemistry

MacKinnon, William J., Professor Emeritus of Psychology

MacLeod, H. Angus, Professor of Optical Sciences and of Electrical and Computer Engineering

Madden, Daniel J., Associate Professor of Mathematics

Maddison, David R., Assistant Professor of Entomology

Maddison, Wayne P., Assistant Professor of Ecology and Evolutionary Biology

Maddox, Thomas III, Professor of Hydrology and Water Resources

Madenci, Erdogan, Assistant Professor of Aerospace and Mechanical Engineering

Madison, Peter, Professor Emeritus of Psychology

Mahajan, Jayashree, Assistant Professor of Marketing

Mahaney, Stephen R., Associate Professor of Computer Science

Mahar, James M., Professor of Near Eastern Studies

Maher, Mary Z., Associate Professor of Theatre Arts

Maher, Alireza, Associate Professor of Plant Sciences

Maher, Hormoz M., Professor Emeritus of Physics

Maier, Robert S., Assistant Professor of Mathematics

Makker, Carol J., Associate Professor of Special Education and Rehabilitation

Malan, T. Philip, Assistant Professor of Anesthesiology

Malik, Joe, Professor Emeritus of Russian and Slavic Languages

Maloney, John C., Professor of Philosophy

Malvick, Allan J., Professor of Civil Engineering and Engineering Mechanics

Manber, Udi, Professor of Computer Science

Manica, Sanjay, Assistant Professor of Computer Science

Mancino, Charles E., Assistant Professor of Plant Sciences

Mangelsdorff, Phillip, Professor Emeritus of Journalism

Mann, Henry B., Professor Emeritus of Mathematics

Mann, Lawrence D., Professor of Geography and Regional Development

Mansfield, Robert W., Associate Professor of Wildlife and Fisheries Science

Manning, Doris E., Professor Emerita of Home Economics

Marcelin, Louis M., Professor Emeritus of Electrical and Computer Engineering

Marchal, John J., Professor of Microbiology and Immunology and of Pathology

Marchello, John A., Professor of Animal Sciences and of Nutrition and Food Science

Marcus, Frank L., Professor of Internal Medicine

Marcet, John, Professor of Veterinary Science

Marefat-Djahromi, Mahmoud, Assistant Professor of Electrical and Computer Engineering

Marley, Jack D., Associate Professor of History

Marion, Mary H., Associate Professor of Family and Consumer Resources

Marsh, Stuart E., Associate Professor of Arid Lands Studies and of Geography and Regional Development

Marshall, Robert H., Professor of Economics

Marshall, Wesley B., Associate Professor of Media Arts

Marsolaski, Chad J., Assistant Professor of Psychology

Marston, Sallie, Associate Professor of Geography and Regional Development

Martin, Lynn, Professor of Medicinal Chemistry in Pharmaceutical Sciences

Martin, Hollis K., Professor Emeritus of Management

Martin, John W., Professor Emeritus of Spanish and Portuguese

Martin, Paul S., Professor Emeritus of Geosciences

Martin, Robert N., Associate Astronomer in the Steward Observatory

Martin, Clark, Professor Emeritus of Range Management

Martin, William E., Professor Emeritus of Agricultural Economics

Martinez, Fernando D., Assistant Professor of Pediatrics

Martinez, Jesus D., Assistant Professor of Radiation Oncology

Martinez, Oscar, Professor of History

Martín, Ralph, Associate Professor of Electrical and Computer Engineering

Martinson, Steven D., Professor of German

Mash, Eugene A., Jr., Associate Professor of Chemistry

Mason, Charles T., Professor Emeritus of Ecology and Evolutionary Biology

Mason, Katherine M., Assistant Professor Emerita of Nursing

Mazumder, Marie, Professor of Law

Matheu, Deborah R., Associate Professor of Political Science and of Philosophy

Matkin, Noel D., Professor of Speech and Hearing Sciences and of English

Matlock, William G., Professor Emeritus of Agricultural Engineering

Matsuda, Kaoru, Associate Professor Emeritus of Molecular and Cellular Biology

Matter, Fred S., Professor of Architecture

Matter, William J., Associate Professor of Wildlife and Fisheries Science

Matthias, Allan D., Associate Professor of Soil and Water Science

Mattingly, Alethea S., Professor Emerita of Speech Communication

Mattson, Roy H., Professor Emeritus of Electrical and Computer Engineering

Mauet, Thomas A., Professor of Law

Maxwell, Margaret F., Professor Emerita of Library Science

May, Warren L., Professor of Mathematics

Mayerson, Michael, Professor of Pharmaceutical Sciences

Mazumdar, Sumitendra, Associate Professor of Physics

McAdam, Douglas J., Professor of Sociology

McAllister, Dean E., Professor Emeritus of Astronomy

McBartley, James C., Associate Professor of Economics

McBride, Robert G., Professor Emeritus of Music

McCallum, William G., Associate Professor of Mathematics

McCarthy, Donald W., Associate Astronomer in the Steward Observatory

McCarthy, Jeanne M., Professor of Special Education and Rehabilitation

McCarty, Teresa, Assistant Professor of Language, Reading and Culture

McCaughhey, William F., Professor Emeritus of Nutrition and Food Science

McClaran, Mitchell P., Associate Professor of Range Management

McClintock, Laura A., Assistant Professor of Psychology

McClure, Michael A., Professor of Plant Pathology

McConnell, Robert E., Professor Emeritus of Architecture

McCord, Beverly B., Professor Emerita of Nursing

McCormick, Floyd G., Professor Emeritus of Agricultural Education

McCoy, Leahmae, Professor Emerita of Economics

McCracken, Betty J., Associate Professor Emerita of Nursing

McCuilen, John D., Professor of Physics

McCullough, Edgar J., Jr., Professor of Geosciences

McDonald, Robert S., Professor of Anatomy and of Physiology

McDade, Lucina A., Assistant Professor of Ecology and Evolutionary Biology

McDaniel, Robert G., Professor Emeritus of Plant Sciences

McDonagh, Paul F., Associate Professor of Surgery

McElroy, Donald M., Professor Emeritus of Aerospace and Mechanical Engineering

McElroy, D. Keith, Associate Professor of Art

McElory, John H., Professor of English

McGraw, John, Associate Astronomer in the Steward Observatory

McGrew, Bruce E., Professor of Art

McIff, H. G., Professor Emeritus of Accounting

McIntyre, Kenneth E., Associate Professor of Surgery

McIntyre, Laurence C., Professor of Physics

McKelvie, Douglas H., Associate Professor Emeritus of Pathology in Pharmaceutical Sciences

McKnight, Brian E., Professor of East Asian Studies

McLaughlin, Carrol M., Associate Professor of Music

McLaughlin, Steven P., Assistant Professor of Arid Lands Studies

McMahon, Ellen, Assistant Professor of Art

McMillan, Robert S., Assistant Research Scientist in the Lunar and Planetary Laboratory

McMillan, Terry L., Associate Professor of English

McMillan, Theodora M., Professor Emerita of Music

McMullen, Nathaniel T., Professor of Anatomy, Neurology, Speech and Hearing Sciences and of English

McNamara, Donald J., Professor of Nutrition and Food Science

McNaughton, Bruce L., Professor of Psychology and of Physiology

McNerney, Gerald M., Professor Emeritus of English

McPherson, E. Gregory, Associate Professor of Landscape Architecture

McPherson, Guy R., Assistant Professor of Watershed Management

McPherson, Joseph M., Professor of Sociology

McQueen, Charlene A., Associate Professor of Pharmacology and Toxicology
Mead, Albert R., Professor Emeritus of Ecology and Evolutionary Biology
Medina, Marcello, Jr., Associate Professor of Educational Foundations and Administration
Meidlinger, Peter E., Associate Professor of English
Medlin, Richard L., Professor of Architecture
Meehan, Eileen R., Associate Professor of Media Arts
Mein, Aden B., Professor Emeritus of Optical Sciences and of Astronomy
Meinke, William J., Professor of Microbiology and Immunology
Melanis, Harvey W., Professor of Surgery
Mellor, Robert S., Associate Professor of Ecology and Evolutionary Biology
Melnik, Amelia, Professor Emerita of Language, Reading, and Culture
Meslow, Henry J., IV, Professor of Planetary Sciences, Geosciences and the Lunar and Planetary Laboratory
Mendelson, Neil, Professor of Molecular and Celluar Biology
Mendez, Miguel M., Professor of Spanish and Portuguese
Mennessier, Mark S., Assistant Professor of Psychiatry, Neurology, and Psychology
Meredith, John A., Associate Professor of Music
Mering, John V., Professor Emeritus of History
Meritt, Curtis B., Professor Emeritus of Educational Psychology
Metcalf, Darrel S., Professor Emeritus of Agronomy
Meyer, Jon W., Professor of Art
Meyers, Michael C., Professor of History
Meyste, Pierre, Professor of Optical Sciences and of Physics
Miao, Ronald C., Associate Professor of East Asian Studies
Michael, Richard E., Professor of Ecology and Evolutionary Biology
Miesfeld, Roger L., Associate Professor of Biochemistry and of Molecular and Cellular Biology
Miklofsky, Haaren A., Professor Emeritus of Civil Engineering and Engineering Mechanics
Miller, Donna M., Professor Emerita of Exercise and Sport Sciences
Miller, Glen M., Associate Professor of Agricultural Education
Miller, Jane R., Professor of English
Miller, Jerry L., Associate Professor Emeritus of Sociology
Miller, Joseph M., Professor Emeritus of Ophthalmology
Miller, Naomi J., Assistant Professor of English
Miller, Patrick B., Assistant Professor of History
Miller, Raina M., Assistant Professor of Soil and Water Sciences
Miller, Thomas P., Associate Professor of English
Miller, Thomas P., Professor of Internal Medicine
Miller, Virginia J., Associate Professor Emerita of Nursing
Miller, Walter B., Professor Emeritus of General Biology
Miller, William B., Assistant Professor of Plant Sciences
Mills, Barbara J., Assistant Professor of Anthropology
Mills, John A., Associate Professor of English
Mills, Timothy J., Associate Professor of Military Aeronautics Studies
Mils, Ronald D., Professor of Philosophy
Milster, Tom D., Assistant Professor of Optical Sciences
Milward, H. Brinton, Associate Professor of Management and Policy
Mirchandani, Pitu B., Professor of Systems and Industrial Engineering
Misaghi, Iraj J., Associate Professor of Plant Pathology
Misheal, Merle H., Professor of Nursing
Mishra, Shitala P., Professor of Educational Psychology
Mitchell, Judy N., Professor of Language, Reading and Culture
Milchheck, Beth, Assistant Professor of Geography and Regional Development
Mittal, Yashawnd, Professor of Statistics
Moises, Alfonso, Associate Professor of Media Arts
Molini, William T., Associate Professor of Plant Sciences
Moll, Luis C., Associate Professor of Language, Reading, and Culture
Molm, Linda D., Professor of Sociology
Monen, Jerome V., Professor of Mathematics and of Optical Sciences
Montel, Navin S., Professor of English
Monk, Janice J., Research Social Scientist in the Southwest Institute for Research on Women
Monke, Eric A., Professor of Agricultural Economics
Monsmann, Gerald, Professor of English
Monte, Renato D., Assistant Professor of Systems and Industrial Engineering
Montfort, William R., Assistant Professor of Biochemistry
Montgomery, Erwin B., Jr., Associate Professor of Neurology
Monty, Dewey E., Professor of Animal Sciences
Moon, Thomas Edward, Professor of Family and Community Medicine
Moors, Arshag, Professor Emeritus of Internal Medicine
Moore, Ida Marie, Associate Professor of Nursing
Moore, Leon, Professor Emeritus of Entomology
Moran, Nancy A., Associate Professor of Ecology and Evolutionary Biology
Morbeck, Mary E., Professor of Anthropology and of Anatomy
Montiel, Diego, Assistant Professor of Economics
Morgan, Florence H., Associate Professor Emerita of English
Morgan, Wayne J., Associate Professor of Pediatrics and of Physiology
Morton, Eugene, Professor of Pharmacology, Internal Medicine, and Physiology
Morrell, Calvin K., Assistant Professor of Communication and of Sociology
Morris, Edward N., Assistant Professor of Psychological Medicine
Morris, Robert A., Professor Emeritus of Medical Physiology
Morrissey, Katherine G., Associate Professor of History
Moynihan, Kevin A., Associate Professor of Art
Mort, Sarah L., Assistant Professor of Library Science
Moynihan, David B., Assistant Professor in the Neuropsychology Division of the Arizona Research Laboratories
Mosher-Kraus, Elizabeth, Professor of Music
Mount, David W., Professor of Molecular and Cellular Biology, Microbiology and Immunology, and Biochemistry
Muczynski, Robert S., Professor Emeritus of Music
Muff, Siraj L., Associate Research Scientist in Pharmacology and Toxicology
Muir, John, Professor Emeritus of English
Muller, John B., Professor of Veterinary Science
Mullen, Steven L., Assistant Professor of Atmospheric Sciences and in the Institute of Atmospheric Physics
Mullen, Edward N., Professor of Political Science
Mulligan, Gordon F., Professor of Geography and Regional Development
Munro, Richard A., Professor Emeritus of Public Administration
Munvey, James E., Professor of Chemistry
Murphy, Richard A., Professor Emeritus of Exercise and Sport Sciences
Muramoto, Hiroshi, Professor Emeritus of Plant Sciences
Murphy, Daniel J., Professor Emeritus of Metallurgical Engineering
Murphy, Edward W., Professor of Music
Murphy, John E., III, Professor of Pharmacy Practice
Murti, Kamakshi P., Assistant Professor of German
Myers, Donald E., Professor of Mathematics
Myers, Eugene W., Jr., Professor of Computer Science and of Molecular and Cellular Biology
Myers, Louis A., Jr., Professor Emeritus of Accounting
Mzcara, Kenneth C., Professor of Electrical and Computer Engineering
Nadel, Lynn, Professor of Psychology
Nagle, Raymond B., Professor of Pathology and of Anatomy
Nagle, William A., Professor of Organic Geology in Geosciences
Nakamoto, Paul Z., Associate Professor of Surgery
Nam, Ilchong, Assistant Professor of Economics
Nanner, Judith A., Associate Professor of Spanish and Portuguese
Narayan, Ramesh, Professor of Astronomy, Arizona Research Laboratories, and Physics
Nash, Pat N., Professor Emeritus of Elementary Education
Nasser, Kam, Associate Professor of Health Education
Nathanson, Tenney, Associate Professor of English
Nevin, Thomas R., Professor Emeritus of Management
Navid, Sennatil, Assistant Professor of Near Eastern Studies
Nederman, Cary J., Assistant Professor of Political Science
Neef, Richmond C., Professor Emeritus of Civil Engineering and Engineering Mechanics
Neher, Patrick K., Assistant Professor of Music
Nelson, Mark A., Assistant Professor of Electrical and Computer Engineering and of Optical Sciences
Nelson, Aaron C., Professor Emeritus of Agricultural Economics
Nelson, Dana A., Professor of Spanish and Portuguese
Nelson, E. Eugene, Professor Emeritus of Nutrition and Food Science
Nelson, Lawrence O., Professor of Educational Foundations and Administration
Nelson, Merritt R., Professor of Plant Pathology
Nelson, William J., Associate Professor Emeritus of Physical Education
Netting, Robert M., Professor of Anthropology
Neuman, Shlomo E., Professor of Hydrology and Water Resources
Neumayer, Leigh A., Assistant Professor of Surgery
Neveux, Marcel F., Professor of Systems and Industrial Engineering
Nevins, Robert L., Professor of Architecture
Newcomb, Richard T., Professor of Mining and Geological Engineering
Newell, Alan C., Professor of Mathematics
Newlin, Phillip B., Professor Emeritus of Civil Engineering and Engineering Mechanics
Newlon, Betty J., Associate Professor Emerita of Family and Consumer Resources
Newman, Charles M., Professor of Mathematics
Newman, Joseph W., Professor Emeritus of Marketing
Nichols, Andrew W., Professor of Family and Community Medicine
Nichols, Roger L., Professor of History
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