“The goals of the University of Arizona are to provide the opportunity for the acquisition of comprehensive education and usable skills, to serve as a resource for the expansion of knowledge through research, and to extend the opportunity to improve the quality of life by making available the services and resources of the University, its faculty and staff, to the students of the University and citizens of the State.”
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 requirements for graduation 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 to award 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 Office of Admissions to determine the acceptability of credit from other institutions and its applicability toward a program of study at the University of Arizona.

The University of Arizona does not discriminate on the basis of sex, age, race, religion, color, national origin, Vietnam Era Veterans' status, or disability in its admissions, employment and educational programs or activities, and is required by Title IX of the Education Amendments of 1972, Title VII of the Civil Rights Act of 1964, Sections 503 and 504 of the Rehabilitation Act of 1973, the Age Discrimination in Employment Act of 1967, and the Vietnam Era Veterans' Readjustment Assistance Act of 1972 not to discriminate in such manner. Inquiries concerning the application of said regulations to the University of Arizona may be referred to Dr. Celestino Fernandez, Affirmative Action Officer, Administration 503, phone (602) 621-3081. In compliance with the Family Education Rights and Privacy Act of 1974, the University of Arizona guarantees that the parents of dependent children will have a right to information about their offspring without having to gain the student's consent.

Announcements in this catalog concerning regulations, fees, curricula, or other matters, are subject to change without notice. Inquiries regarding admission to the Graduate College should be addressed to:

Graduate Admissions Office
Administration 107
The University of Arizona
Tucson, Arizona 85721
(602) 621-3132

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Contents

DIRECTIONS FOR CORRESPONDENCE .............................................. 7
ACADEMIC DIVISIONS OF THE UNIVERSITY ...................................... 8
ABBREVIATION GUIDE .................................................................. 9
GRADUATE CALENDAR .................................................................... 11
ARIZONA BOARD OF REGENTS .......................................................... 14
UNIVERSITY ADMINISTRATION ......................................................... 14
  Officers of the Administration ...................................................... 14
  Graduate Council ....................................................................... 15
  Committee on Graduate Study ...................................................... 15
TEACHING AND RESEARCH FACULTY ................................................. 17
GENERAL INFORMATION ................................................................ 43
  Accommodation of Religious Observance and Practice .................. 43
  Facilities and Services .................................................................. 43
  Cooperating Organizations ........................................................... 43
  Fees .......................................................................................... 54
  Housing ..................................................................................... 55
  University Dining Service ............................................................ 56
  Student Counseling and Services ................................................... 56
GENERAL REGULATIONS .................................................................. 57
  The Nature of Graduate Work ....................................................... 57
  Admission ................................................................................... 57
    Regular Graduate Status ............................................................ 57
    Unclassified Graduate Status ...................................................... 57
    Admission of Foreign Students .................................................. 57
  Application for Admission ............................................................. 58
  Graduate Record Examinations ...................................................... 58
  Candidacy for an Advanced Degree ............................................... 59
  Graduate Credit for Seniors and Unclassified (Not Graduate) Students ............................................ 59
  General Prerequisites for Major Graduate Credit ............................ 59
  Regular Graduate Credit Courses .................................................. 59
  Other Courses for Graduate Credit ............................................... 59
  Transfer of Graduate Credit .......................................................... 60
  Correspondence Courses ............................................................... 60
  Grading System .......................................................................... 60
  Examinations Required ................................................................. 60
  Withdrawal Grades ...................................................................... 60
  Special Grades ........................................................................... 60
  Averaging of Grades .................................................................... 61
  Pass-Fail Option ......................................................................... 61
  Removal of Incomplete ................................................................. 61
  Scholarship Requirements .............................................................. 61
  Full-Time Student Status ............................................................... 61
  Maximum Enrollment .................................................................... 61
  Minimum Enrollment (See Supplementary Registration) .................. 61
  Supplementary Registration ........................................................... 61
  Thesis and Dissertation Work in Absentia ....................................... 62
  Auditing of Courses by Graduate Students ..................................... 62
  Graduate Study in Summer Sessions ............................................ 62
  Graduate Appointments, Scholarships, and Financial Aids ............... 62
DIRECTIONS FOR CORRESPONDENCE

Prospective graduate students are asked to correspond with officials of the University as follows:

The Graduate College Admissions Office concerning admission to the regular and summer sessions, progress of pending admission applications, and general regulations.

Head of particular department for further information on departmental course offerings, degree programs, graduate assistantships, and tuition and academic scholarships.

Director of Continuing Education for announcements of continuing education programs.

Coordinator of Summer Session for summer session announcements.

Dean of the College of Education for guidance relative to course offerings in education, requirements for certification of teachers.

Director of Student Financial Aid for information about loans, college work-study programs, and other forms of financial assistance.

Director of Career and Placement Services for information on part-time employment, teaching positions.

Director of Residence Life for information on living accommodations.

Registrar concerning transcripts.
ACADEMIC DIVISIONS OF THE UNIVERSITY

COLLEGE OF AGRICULTURE. School of Family and Consumer Resources (with divisions of Child Development and Family Relations; Clothing, Textiles and Interior Design; Home Economics Education/Consumer Studies); School of Renewable Natural Resources (with programs in Landscape Architecture, Natural Resource Recreation, Range Management, Watershed Management, Wildlife and Fisheries Science). Departments of: Agricultural Economics; Agricultural Education; Animal Sciences; Entomology; Nutrition and Food Science; Plant Pathology; Plant Sciences; Soils, Water and Engineering; Veterinary Science. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology.

COLLEGE OF ARCHITECTURE

COLLEGE OF ARTS AND SCIENCES. School of Music. Departments of: Anthropology; Art; Astronomy; Atmospheric Sciences; Chemistry; Classics; Computer Science; Drama; Ecology and Evolutionary Biology; English; French and Italian; Geography and Regional Development; Geosciences; German; History; Journalism; Linguistics; Mathematics; Oriental Studies; Philosophy; Physics; Planetary Sciences; Political Science; Psychology; Radio-Television; Russian and Slavic Languages; Sociology; Spanish and Portuguese; Speech and Hearing Sciences; Speech Communication; Statistics. University Departments of Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology. Committee on Dance.

COLLEGE OF BUSINESS AND PUBLIC ADMINISTRATION. Departments of: Accounting; Economics; Finance and Real Estate; Management and Policy; Management Information Systems; Marketing.

COLLEGE OF EDUCATION. Graduate Library School; Center for the Study of Higher Education. Departments of: Business and Career Education; Counseling and Guidance; Educational Foundations and Administration; Educational Psychology; Elementary Education; Reading; Rehabilitation; Secondary Education; Special Education.

COLLEGE OF ENGINEERING. Departments of: Aerospace and Mechanical Engineering; Civil Engineering and Engineering Mechanics; Electrical and Computer Engineering; Hydrology and Water Resources; Nuclear and Energy Engineering; Systems and Industrial 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; Radiology; Surgery. University Departments of Biochemistry, Microbiology and Immunology; Molecular and Cellular Biology.

COLLEGE OF MINES. Departments of: Chemical Engineering; Materials Science and Engineering; Mining and Geological Engineering.

COLLEGE OF NURSING

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

GRADUATE COLLEGE. Committees on: Animal Physiology; Arid Lands Resource Sciences; Environment and Behavior; Genetics; History and Philosophy of Science; Medieval Studies; Nutritional Sciences; Optical Sciences; Pharmacology and Toxicology; Planning; Plant Protection; Romance Languages; Toxicology.

GENERAL DEPARTMENTS. Exercise and Sport Sciences; School of Health-Related Professions; School of Military Science, Naval Science, and Military Aerospace Studies

UNIVERSITY DEPARTMENTS. Biochemistry, Microbiology and Immunology; Molecular and Cellular Biology.

GENERAL COMMITTEES. American Indian Studies; Applied Mathematics; Biomedical Engineering; Black Studies; Business Administration; Gerontology; Humanities; Latin American Studies; Mexican American Studies; Religious Studies; Remote Sensing; Women's Studies.

CONTINUING EDUCATION.

THE UNIVERSITY LIBRARIES
## 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>
</tr>
</thead>
<tbody>
<tr>
<td>a.ec.</td>
<td>agricultural economics</td>
</tr>
<tr>
<td>a.ed.</td>
<td>agricultural education</td>
</tr>
<tr>
<td>a.en.</td>
<td>agricultural engineering</td>
</tr>
<tr>
<td>a.m.e.</td>
<td>aerospace and mechanical engineering</td>
</tr>
<tr>
<td>a.ph.</td>
<td>animal physiology</td>
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<tr>
<td>acct.</td>
<td>accounting</td>
</tr>
<tr>
<td>agri.</td>
<td>agriculture</td>
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<tr>
<td>A.In.s</td>
<td>American Indian studies</td>
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<td>an.s.</td>
<td>animal sciences</td>
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<td>anat.</td>
<td>anatomy</td>
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<td>anes.</td>
<td>anesthesiology</td>
</tr>
<tr>
<td>appl.</td>
<td>applied mathematics</td>
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<tr>
<td>ar.l.</td>
<td>arid lands resource sciences</td>
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<tr>
<td>arch.</td>
<td>architecture</td>
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<td>art.</td>
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<tr>
<td>astr.</td>
<td>astronomy</td>
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<td>atmospheric sciences</td>
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<td>business administration</td>
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<td>b.c.ed.</td>
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<td>biol.</td>
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<tr>
<td>Bl.s.</td>
<td>Black Studies</td>
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<tr>
<td>c.e.</td>
<td>civil engineering</td>
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<tr>
<td>c.d.f.r.</td>
<td>child development and family relations</td>
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<td>counseling and guidance</td>
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<td>c.t.</td>
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<td>e.c.e.</td>
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<td>ecol.</td>
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<td>exercise and sport sciences</td>
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<td>f.c.m.</td>
<td>family and community medicine</td>
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<td>family and consumer resources</td>
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<td>honors</td>
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<td>med.</td>
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<td>microbiology and immunology</td>
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<td>management information systems</td>
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<td>obstetrics and gynecology</td>
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<td>Acronym</td>
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<td>pty.s.</td>
<td>planetary sciences</td>
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<td>R.lg.</td>
<td>Romance languages</td>
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<td>radiology</td>
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<td>Russian and Slavic languages</td>
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<tr>
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</tr>
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# GRADUATE CALENDAR

<table>
<thead>
<tr>
<th>Event</th>
<th>1985-86</th>
<th>1986-87</th>
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<tbody>
<tr>
<td>Deadline for complete applications for admission</td>
<td>July 22, M</td>
<td>July 21, M</td>
</tr>
<tr>
<td>Degrees awarded as of this date for students</td>
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<tr>
<td>completing requirements at close of summer session</td>
<td>Aug. 15, Th</td>
<td>Aug. 14, Th</td>
</tr>
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<td>Residence halls open</td>
<td>Aug. 18, Su</td>
<td>Aug. 17, Su</td>
</tr>
<tr>
<td>Registration</td>
<td>Aug. 21-23, W-F</td>
<td>Aug. 20-22, W-F</td>
</tr>
<tr>
<td>Classes begin</td>
<td>Aug. 26, M</td>
<td>Aug. 25, M</td>
</tr>
<tr>
<td>Labor Day - no classes</td>
<td>Sept. 2, M</td>
<td>Sept. 1, M</td>
</tr>
<tr>
<td>Deadline for petitions for graduate credit</td>
<td>Sept. 3, Tu</td>
<td>Sept. 2, Tu</td>
</tr>
<tr>
<td>Last day to register for credit, to add</td>
<td>Sept. 3, Tu</td>
<td>Sept. 2, Tu</td>
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<tr>
<td>courses, and to change from no credit to credit</td>
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<tr>
<td>Last day to file Master's Degree Study Program</td>
<td>Sept. 9, M</td>
<td>Sept. 8, M</td>
</tr>
<tr>
<td>for completion in December</td>
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</tr>
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<td>Last day to drop with deletion of course from record</td>
<td>Sept. 20, F</td>
<td>Sept. 19, F</td>
</tr>
<tr>
<td>Records close for midsemester scholarship report</td>
<td>Oct. 8, Tu</td>
<td>Oct. 7, Tu</td>
</tr>
<tr>
<td>Last day for doctoral students to file</td>
<td></td>
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<tr>
<td>Doctoral Degree Study Program for completion in May 1986; May 1987</td>
<td>Oct. 25, F</td>
<td>Oct. 24, F</td>
</tr>
<tr>
<td>Last day to drop courses and to change</td>
<td>Nov. 1, F</td>
<td>Oct. 31, F</td>
</tr>
<tr>
<td>from credit to no credit</td>
<td>Nov. 11, M</td>
<td>Nov. 11, Tu</td>
</tr>
<tr>
<td>Veterans' Day - no classes</td>
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<td></td>
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<tr>
<td>Last day to take doctoral final oral examination for December completion</td>
<td>Nov. 25, M</td>
<td>Nov. 21, F</td>
</tr>
<tr>
<td>Thanksgiving recess</td>
<td>Nov. 21-24</td>
<td>Nov. 27-30</td>
</tr>
<tr>
<td>Last day to pay fees for doctoral degree candidacy</td>
<td>Nov. 28, Th</td>
<td>Nov. 25, Tu</td>
</tr>
<tr>
<td>and dissertation processing and microfilming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last day to submit approved, library-ready copies of</td>
<td>Nov. 29, F</td>
<td>Nov. 26, W</td>
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<tr>
<td>dissertation for December completion</td>
<td></td>
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</tr>
<tr>
<td>Last day to file Report on Master's Final Examination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>for December completion (thesis, if any, must have</td>
<td>Dec. 2, M</td>
<td>Dec. 1, M</td>
</tr>
<tr>
<td>preliminary approval by Graduate College after</td>
<td></td>
<td></td>
</tr>
<tr>
<td>final examination)</td>
<td>Dec. 11, W</td>
<td>Dec. 10, W</td>
</tr>
<tr>
<td>Class and laboratory sessions end</td>
<td>Dec. 12, Th</td>
<td>Dec. 12, F</td>
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<tr>
<td>Semester examinations begin</td>
<td></td>
<td></td>
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<tr>
<td>Last day to submit approved, library-ready copies of</td>
<td>Dec. 16, M</td>
<td>Dec. 15, M</td>
</tr>
<tr>
<td>thesis for December completion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last day to pay fees for master's and specialist</td>
<td>Dec. 19, Th</td>
<td>Dec. 19, F</td>
</tr>
<tr>
<td>degree candidacy and thesis processing</td>
<td>Dec. 19, Th</td>
<td>Dec. 19, F</td>
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<tr>
<td>Semester examinations end</td>
<td>Dec. 20, F</td>
<td>Dec. 20, Sa</td>
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<tr>
<td>Commencement</td>
<td></td>
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<tr>
<td>Event</td>
<td>1985-86</td>
<td>1986-87</td>
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<tr>
<td>-------------------------------------------</td>
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<tr>
<td>Deadline for complete applications for admission</td>
<td>Dec. 27, F</td>
<td>Dec. 26, F</td>
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<tr>
<td>Registration</td>
<td>Jan. 13-15, M-W</td>
<td>Jan. 12-14, M-W</td>
</tr>
<tr>
<td>Classes begin</td>
<td>Jan. 16, Th</td>
<td>Jan. 15, Th</td>
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<tr>
<td>Last day for doctoral preliminary examination for May completion</td>
<td>Jan. 21, Tu</td>
<td>Jan. 20, Tu</td>
</tr>
<tr>
<td>Last day to file Application for Candidacy for May completion of doctoral requirements</td>
<td>Jan. 21, Tu</td>
<td>Jan. 20, Tu</td>
</tr>
<tr>
<td>Deadline for petitions for graduate credit</td>
<td>Jan. 23, Th</td>
<td>Jan. 22, Th</td>
</tr>
<tr>
<td>Last day to register for credit, to add courses, and to change from no credit to credit</td>
<td>Jan. 23, Th</td>
<td>Jan. 22, Th</td>
</tr>
<tr>
<td>Last day to file Master’s Degree Study Program for completion in May</td>
<td>Feb. 3, M</td>
<td>Feb. 2, M</td>
</tr>
<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Feb. 12, W</td>
<td>Feb. 11, W</td>
</tr>
<tr>
<td>President’s Day</td>
<td>Feb. 17, M</td>
<td>Feb. 16, M</td>
</tr>
<tr>
<td>La Fiesta de los Vaqueros - no classes</td>
<td>Feb. 27, Th</td>
<td>Feb. 26, Th</td>
</tr>
<tr>
<td>Records close for midterm scholarship report</td>
<td>Feb. 28, F</td>
<td>Feb. 27, F</td>
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<tr>
<td>Spring recess</td>
<td>Mar. 15-23</td>
<td>Mar. 14-22</td>
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<tr>
<td>Last day to file Master’s Degree Study Program for summer completion</td>
<td>Mar. 28, F</td>
<td>Mar. 27, F</td>
</tr>
<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Apr. 2, W</td>
<td>Apr. 1, W</td>
</tr>
<tr>
<td>Last day to file Report on Master’s Final Examination for May completion</td>
<td>Apr. 21, M</td>
<td>Apr. 20, M</td>
</tr>
<tr>
<td>(thesis, if any, must have preliminary approval by Graduate College after final examination)</td>
<td></td>
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</tr>
<tr>
<td>Last day to take doctoral final oral examination for May completion</td>
<td>Apr. 21, M</td>
<td>Apr. 20, M</td>
</tr>
<tr>
<td>Last day to pay fees for doctoral degree candidacy and dissertation processing and microfilming</td>
<td>Apr. 24, Th</td>
<td>Apr. 23, Th</td>
</tr>
<tr>
<td>Last day to submit approved, library-ready copies of dissertation for May completion</td>
<td>Apr. 25, F</td>
<td>Apr. 24, F</td>
</tr>
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<td>Last day to submit approved, library-ready copies of thesis for May completion</td>
<td>May 5, M</td>
<td>May 4, M</td>
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<tr>
<td>Class and laboratory sessions end</td>
<td>May 7, W</td>
<td>May 6, W</td>
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<tr>
<td>Semester examinations begin</td>
<td>May 9, F</td>
<td>May 8, F</td>
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<tr>
<td>Last day to pay fees for master’s degree candidacy and thesis processing</td>
<td>May 16, F</td>
<td>May 15, F</td>
</tr>
<tr>
<td>Semester examinations end</td>
<td>May 16, F</td>
<td>May 15, F</td>
</tr>
<tr>
<td>Commencement</td>
<td>May 17, Sa</td>
<td>May 16, Sa</td>
</tr>
<tr>
<td>Event</td>
<td>1986</td>
<td>1987</td>
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<td>-----------------------------------------------------------</td>
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<tr>
<td><strong>Summer Sessions</strong></td>
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<tr>
<td><strong>Presession</strong></td>
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<tr>
<td>Registration</td>
<td>May 19-20, M-Tu</td>
<td>May 18-19, M-Tu</td>
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<tr>
<td>Presession classes begin</td>
<td>May 19, M</td>
<td>May 18, M</td>
</tr>
<tr>
<td>Holiday - no classes</td>
<td>May 26, M</td>
<td>May 25, M</td>
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<tr>
<td>Last day of classes and final examination day</td>
<td>June 7, Sa</td>
<td>June 6, Sa</td>
</tr>
<tr>
<td><strong>First Summer Session</strong></td>
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<tr>
<td>Registration</td>
<td>June 6, F</td>
<td>June 5, F</td>
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<tr>
<td>First summer session begins</td>
<td>June 9, M</td>
<td>June 8, M</td>
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<tr>
<td>Holiday - no classes</td>
<td>July 4, F</td>
<td>July 3, F</td>
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<tr>
<td>Last day of classes and final examination day</td>
<td>July 10, Th</td>
<td>July 9, Th</td>
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<tr>
<td><strong>Second Summer Session</strong></td>
<td></td>
<td></td>
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<tr>
<td>Registration</td>
<td>July 11, F</td>
<td>July 10, F</td>
</tr>
<tr>
<td>Second summer session begins</td>
<td>July 14, M</td>
<td>July 13, M</td>
</tr>
<tr>
<td>Last day to file Report on Master's Final Examination</td>
<td>July 21, M</td>
<td>July 20, M</td>
</tr>
<tr>
<td>for August completion (thesis, if any, must have preliminary approval by Graduate College after final examination)</td>
<td></td>
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<tr>
<td>Last day to submit approved, library-ready copies of master's thesis for August completion</td>
<td>Jul. 30, W</td>
<td>Jul. 29, W</td>
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<tr>
<td>Last day to take doctoral final oral examination for August completion</td>
<td>Aug. 12, Tu</td>
<td>Aug. 11, Tu</td>
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<tr>
<td>Last day to submit approved, library-ready copies of dissertation for August completion</td>
<td>Aug. 13, W</td>
<td>Aug. 12, W</td>
</tr>
<tr>
<td>Last day to pay fees for degree candidacy, thesis and dissertation processing and dissertation microfilming</td>
<td>Aug. 13, W</td>
<td>Aug. 12, W</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>Aug. 13, W</td>
<td>Aug. 12, W</td>
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</tbody>
</table>
Arizona Board of Regents

EX OFFICIO

BRUCE E. BABBITT, J.D. ............................................ Governor of Arizona
CAROLYN P. WARNER .................................................. State Superintendent of Public Instruction

APPOINTED

NORA ANN COLTON, B.S. ............................................ July, 1986
DONALD PITT, J.D., President ....................................... January, 1986
ESTHER N. CAPIN, M.Ed. ........................................... January, 1986
TIO A. TACHIAS ....................................................... January, 1986
WILLIAM P. REILLY, Treasurer ................................. January, 1986
DONALD G. SHROPSHIRE, B.S., Secretary ................... January, 1986
A. JACK PFISTER, LL.B., President-Elect ..................... January, 1990
EDITH S. AUSLANDER, M.A. ...................................... January, 1992
HERMAN CHANEN, Assistant Secretary ......................... January, 1992

University Administration
(Year of first appointment to faculty follows each name.)

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RICHARD ANDERSON HARVILL (1934) ............................... President Emeritus of the University
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BEN J. TUCHI (1985) ................................................ Senior Vice President for Administration and Finance
LEE B. JONES (1964) ................................................. Vice President for Research and Dean of the Graduate College
DUDLEY B. WOODARD, JR. (1983) ................................. Vice President for Student Affairs
ALLAN BEIGEL (1970) ............................................... Vice President of University Relations and Development
GEORGE R. CUNNINGHAM, JR. (1977) ............................ Vice President for Administrative Services
LAUREL L. WILKENING (1973) ...................................... Vice Provost for Academic Affairs
ALBERT B. WEAVER (1958) ......................................... Executive Vice President Emeritus
RICHARD M. EDWARDS (1959) ..................................... Vice President Emeritus for Student Relations
ARNO RICHARD KASSANDER (1954) ................................. Vice President Emeritus for Research
SHERWOOD E. CARR (1954). ....................................... Treasurer and Contracting Officer Emeritus

GRADUATE COLLEGE OFFICERS

LEE B. JONES (1964) ................................................ Vice President for Research and Dean of the Graduate College
HERBERT DAWSON RHODES (1943) ................................. Dean Emeritus of the Graduate College
CURTIS BRADFORD MERRITT (1949) ............................... Associate Dean Emeritus of the Graduate College
JANE H. UNDERWOOD (1968) ..................................... Associate Dean of the Graduate College
RICHARD F. CURLEE (1974) ...................................... Associate Dean of the Graduate College

DEANS

ROSALIND E. ANDREAS (1985) .................................... Dean of Students
MYLES BRAND (1981) ................................................ Dean of the Faculty of Social and Behavioral Sciences, College of Arts and Sciences
BARTLEY P. CARDON (1980) ....................................... Dean of the College of Agriculture
JACK R. COLE (1957) ............................................... Dean of the College of Pharmacy
GARY D. FENSTERMACHER (1985) ................................. Dean of the College of Education
RONALD GOURLY (1978) ........................................... Dean of the College of Architecture
DONALD J. IRVING (1982) .......................................... Dean of the Faculty of Fine Arts, College of Arts and Sciences
LOUIS J. KETTEL (1968) ........................................... Dean of the College of Medicine
RICHARD P. KINKADE (1982) ..................................... Dean of the Faculty of Humanities, College of Arts and Sciences
PAUL MARCUS (1983) ............................................... Dean of the College of Law
EDGAR J. McCULLOUGH, JR. (1957) .............................. Dean of the Faculty of Science, College of Arts and Sciences
KENNETH R. SMITH (1980) ........................................ Dean of the College of Business and Public Administration
GLADYS ELAINE SORENSSEN (1958) ............................... Dean of the College of Nursing
RICHARD A. SWALIN (1984) ...................................... Interim Dean of the College of Engineering
GRADUATE COUNCIL

H. Vasken Aposhian ...................................................... Professor of Molecular and Cellular Biology and of Pharmacology
Barbara A. Babcock ....................................................... Professor of English
Richard F. Currie ......................................................... Professor of Speech and Hearing Sciences
George H. Davis ............................................................ Associate Professor of Geosciences
William G. Dever .......................................................... Professor of Oriental Studies
Den S. Dhaoui ............................................................... Professor of Accounting
David A. Gay ............................................................... Associate Professor of Mathematics
Joseph F. Gross ............................................................. Professor of Chemical Engineering
David J. Hartshorne .......................................................... Professor of Nutrition and Food Science and of Biochemistry
Lee B. Jones ................................................................ Vice President for Research and Dean of the Graduate College, Chairman
Larry L. Leslie ................................................................. Professor of Higher Education
Michael B. Meyerson .......................................................... Professor of Pharmaceutical Sciences
Beverly A. McCord .......................................................... Professor of Nursing
Glen I. Nicholson ........................................................... Professor of Educational Psychology
Ellwood C. Parry .............................................................. Professor of Art
John S. Ramberg ............................................................ Professor of Systems and Industrial Engineering
William H. Sewell .......................................................... Associate Professor of Physiology
Richard L. Stouffer .......................................................... Professor of History
Jane H. Underwood .......................................................... Professor of Anthropology
Mary C. Wetzel ............................................................... Professor of Psychology

COMMITTEE ON GRADUATE STUDY

Marc Aaronson (1988)* ...................................................... Associate Professor of Astronomy
Ronald E. Allen (1985) ...................................................... Associate Professor of Animal Sciences
Karen Sue Anderson (1987) ................................................. Assistant Professor of History
Gregory R. Andrews (1988) ................................................ Associate Professor of Computer Science
Jay B. Angelvine, Jr. (1985) .................................................. Professor of Anatomy
Bruno Baldessari (1988) ......................................................... Professor of Anatomy
Paul G. Bartels (1987) ......................................................... Professor of Statistics
Ellen S. Basso (1987) .......................................................... Professor of Anthropology
Marlene Bence (1986) .......................................................... Associate Professor of Rehabilitation
Bryant Benson (1985) .......................................................... Professor of Anatomy
Walter H. Birky (1985) ......................................................... Physical Anthropologist
Homer Earl Bloss (1987) ...................................................... Associate Professor of Plant Pathology
John M. Boe (1987) ............................................................. Professor of Music
Klaus Brendel (1986) .......................................................... Professor of Pharmacology
William Hedrick Brown (1986) ................................................ Professor of Animal Sciences
James Joseph Burke (1988) .................................................. Professor of Optics
Wayne R. Carroll (1986) ...................................................... Associate Professor of Psychology
Clement G. Chase (1988) ...................................................... Professor of Geosciences
David Hollister Chisholm (1988) ............................................. Professor of German
Victor A. Christopherson (1987) ......................................... Professor of Family and Consumer Resources
Jeanne O. Nienaber Clarke (1987) ......................................... Associate Professor of Political Science
Terry Connolly (1988) ......................................................... Professor of Management and Policy
Dinshaw Contractor (1986) .................................................. Professor of Civil Engineering and Engineering Mechanics
Richard A. Cosgrove (1987) ................................................ Associate Professor of History
Susan Deeds (1988) .......................................................... Assistant Professor of Latin American Studies
Richard Maxwell Eaton (1987) .............................................. Associate Professor of Oriental Studies
John T. Emery (1986) .......................................................... Associate Professor of Finance and Real Estate
Henry Lee Ewbank (1988) ................................................... Professor of Speech Communication
Rocco Anthony Fazzolare (1988) ............................................ Associate Professor of Nuclear and Energy Engineering
Joel Feinberg (1988) .......................................................... Professor of Philosophy
Martin Mark Fogel (1985) ................................................... Professor of Watershed Management
Juan R. Garcia (1986) .......................................................... Associate Professor of History
Margaret I. Gibson (1988) .................................................. Professor of Russian and Slavic Languages
John J. Gilbert (1988) ......................................................... Professor of Spanish and Portuguese
R. Kenneth Godwin (1987) .................................................. Associate Professor of Political Science
Andrew M. Goldner (1985) .................................................. Associate Professor of Physiology
Yetta M. Goodman (1987) .................................................... Professor of Elementary Education
Kari C. Gregg (1987) .......................................................... Associate Professor of Spanish and Portuguese
Lanin A. Gyurko (1986) ....................................................... Professor of Spanish and Portuguese
Richard N. Henderson (1987) ............................................. Professor of Anthropology
Martinez J. Hewlett (1987) .................................................. Associate Professor of French and Francophone Studies
Bill W. Hillman (1986) ....................................................... Professor of Counseling and Guidance
Ada Sue Hinshaw (1986) ..................................................... Associate Professor of English
Jerrold E. Hogle (1987) ...................................................... Associate Professor of Political Science
Thomas M. Holm (1988) ..................................................... Professor of Animal Sciences
John Talmage Huber (1988) .................................................. Associate Professor of Political Science
Roger T. Huber (1985)  Professor of Entomology
Robert J. Janssen (1987)  Associate Professor of Microbiology and Immunology
Gary Franklin Jensen (1988)  Associate Professor of Sociology
Rudolf A. Jimenez (1987)  Professor of Civil Engineering and Engineering Mechanics
Keith M. Johnson (1988)  Associate Professor of Music
Jack R. Jokipii (1988)  Professor of Planetary Sciences
Philip C. Keller (1986)  Professor of Physics and of Microbiology
Rein Kilkson (1985)  Professor of Psychology
James E. King (1985)  Professor of Range Management
Ingeborg Margaret Kohr (1987)  Associate Professor of French and Italian
Frank K. La Ban (1988)  Professor of Speech Communication
Philip J. Lauver (1986)  Associate Professor of Counseling and Guidance
Averill Martin Law (1986)  Professor of Management Information Systems
Kai Y. Lei (1988)  Professor of Nutrition and Food Science
Robert C. Leonard (1987)  Professor of Sociology
James Otto Klemmedson (1988)  Professor of Range Management
Philip C. Keller (1986)  Professor of Physics and of Microbiology
Rein Kilkson (1985)  Professor of Psychology
James E. King (1985)  Professor of Range Management
Ingeborg Margaret Kohr (1987)  Associate Professor of French and Italian
Frank K. La Ban (1988)  Professor of Speech Communication
Philip J. Lauver (1986)  Associate Professor of Counseling and Guidance
Averill Martin Law (1986)  Professor of Management Information Systems
Kai Y. Lei (1988)  Professor of Nutrition and Food Science
Robert C. Leonard (1987)  Professor of Sociology
Richard L. Lopez, Jr. (1986)  Assistant Professor of Elementary Education
David Lovecock (1988)  Professor of Mathematics
Arvind S. Marathay (1985)  Professor of Systems and Industrial Engineering
Robert H. Marshall (1985)  Associate Professor of Optimal Sciences
Bruce Elwin McGrew (1996)  Professor of Art
David M. McLaughlin (1988)  Professor of Economics
Peter Ernest Medina (1988)  Associate Professor of English
Marcello Medina, Jr. (1985)  Associate Professor of Educational Foundations and Administration
Shitala Prasad Mishra (1988)  Associate Professor of Educational Psychology
Judy Nichols Mitchell (1987)  Associate Professor of Reading
Gordon F. Mulligan (1988)  Associate Professor of Geography and Regional Development
Lawrence O. Nelson (1988)  Professor of Educational Administration
Richard Newcomb (1986)  Professor of Mining and Geological Engineering
Betty J. Newlon (1986)  Assistant Professor of Counseling and Guidance
Glenn S. Pate (1985)  Associate Professor of Secondary Education
Ian L. Pepper (1987)  Associate Professor of Soils, Water and Engineering
Stanley Pogrow (1985)  Associate Professor of Educational Foundations and Administration
Srinivasa Raghavan (1986)  Associate Professor of Materials Science and Engineering
Donald E. Ray (1986)  Professor of Animal Sciences
James Jefferson Reid, Jr. (1985)  Associate Professor of Anthropology
Robert R. Rice (1988)  Professor of Family and Consumer Resources
Kathryn R. E. Russell (1985)  Associate Professor of Exercise and Sport Sciences
Stephen M. Russell (1986)  Associate Professor of Ecology and Evolutionary Biology
Donald M. Sacken (1987)  Associate Professor of Educational Foundations and Administration
Amos P. Sales (1988)  Professor of Rehabilitation
T. Frank Saunders (1988)  Professor of Educational Foundations and Administration
Alice E. Schiebel (1985)  Professor of Anthropology
Kari H. Schram (1986)  Associate Professor of Pharmaceutical Sciences
Donald G. Schultz (1985)  Professor of Systems and Industrial Engineering
Lawrence B. Scott, Jr. (1986)  Professor of Aerospace and Mechanical Engineering
Farhang Shadman (1986)  Associate Professor of Chemical Engineering
Ralph L. Shelton (1985)  Professor of Speech and Hearing Sciences
Michael D. Shields (1988)  Professor of Accounting
Eugene S. Simpson (1988)  Professor of Hydrology and Water Resources
Norman S. Smith (1986)  Professor of Wildlife Ecology
Dean O. Staley (1988)  Professor of Atmospheric Sciences
Orestes N. Stavroudis (1988)  Professor of Optimal Sciences
Malur Sundareshan (1986)  Associate Professor of Electrical and Computer Engineering
Gordon Tollin (1987)  Professor of Biochemistry
Paul R. Turner (1988)  Professor of Anthropology
G. Krishna Venupallal (1985)  Associate Professor of Chemistry
David L. Venable (1988)  Assistant Professor of Ecology and Evolutionary Biology
David J. A. Vleck (1985)  Professor of Physics
Joseph J. Vuillemin (1986)  Professor of Anthropology
Thomas Weaver (1986)  Professor of Exercise and Sport Sciences
Clifton E. Wilson (1988)  Professor of Political Science

*Term expiration.
Teaching and Research Faculty

Aamodt, Agnes Marie, Professor of Nursing
Aaronson, Marc, Associate Professor of Astronomy
Abraham, Kitty L.G., Associate Professor of Family and Consumer Resources
Abrams, Herbert Kerman, Professor Emeritus of Family and Community Medicine
Adamec, Ludwig Warran, Professor of Oriental Studies
Adams, William Grant, Associate Professor of Art
Ahmann, Frederick Rauch, Assistant Professor of Internal Medicine
Aiken, Susan Hardy, Associate Professor of English
Albanese, Charles Anthony, Professor of Architecture
Alberts, David S., Professor of Internal Medicine
Alcorn, Stanley Marcus, Professor of Plant Pathology
Aleamoni, Lawrence Massud, Professor of Educational Psychology
Alepa, Francis P., Professor of Internal Medicine
Alexander, Mary A., Assistant Professor of Nursing
Alfonso, Michael, Assistant Professor of Naval Science
Allen, Adela, Associate Professor of Reading
Allen, Hugh D., Professor of Pediatrics
Allen, Paul Malcolm, Professor of Secondary Education
Allen, R. Van, Professor Emeritus of Elementary Education
Allen, Ronald Eugene, Associate Professor of Animal Sciences and of Nutrition and Food Science
Allen, Roes Marvin, Professor Emeritus of Plant Pathology
Allen, Rupert Clyde, Jr., Professor of Spanish and Portuguese
Allen, Ruth Amelia, Professor Emerita of Home Economics
Altman, Ellen, Professor of Library Science
Altschul, D. Robert, Associate Professor of Geography and Regional Development
Alvi, Eskander, Professor of Economics
Amberg, John R., Professor of Radiology
Ames, Wilbur Stanley, Professor of Reading
Amy, Gary Lee, Associate Professor of Civil Engineering and Engineering Mechanics
Anastasio, Geraldine Diane, Associate Professor of Pharmacy Practice
Anders, Patricia Lee, Associate Professor of Reading
Anderson, Jon, Associate Professor of English
Anderson, Karen Sue, Associate Professor of History
Anderson, Robert M., Associate Professor of Surgery
Anderson, Roger A., Professor Emeritus of Aerospace and Mechanical Engineering
Anderson, Waldo Keith, Professor of Higher Education
Anderson, Warren H., Professor of Art
Andrews, Arthur William, Professor of Law
Andrews, Gregory Richard, Associate Professor of Computer Science
Angel, J. Roger P., Professor of Astronomy
Angerville, Jay Bernard, Jr., Professor of Anatomy
Angus, Robert Chauncey, Professor of Agricultural Economics
Anthony, James Raymond, Professor of Music
Anthony, John Williams, Professor Emeritus of Geosciences
Antia, Shirin, Assistant Professor of Special Education
Antley, Elizabeth Martin, Professor of Reading
Aposthain, H. Vasken, Professor of Molecular and Cellular Biology and of Pharmacology
Aquillano, Nicholas, Associate Professor of Management and Policy
Arau, Charles E., Professor of Law
Aristizabal, Silvio Antonio, Professor of Radiology
Arkowitz, Harold S., Associate Professor of Psychology
Armstrong, Edward Paul, Assistant Professor of Pharmacy Practice
Armstrong, Neal Russell, Associate Professor of Chemistry
Aascher, Mark L., Associate Professor of Law
Atkinson, George, Professor of Chemistry
Attarian, Peter J., Associate Professor of Family and Community Medicine
Atwater, Anne Elizabeth, Professor of Exercise and Sport Science
Atwood, Harry W., Associate Professor of Radio and Television Film Production
Atwood, Janet R., Professor of Nursing
Austin, John Norman, Professor of Classics
Avery, Arthur, Professor of Family and Consumer Resources
Babcock, Barbara Anne, Professor of English
Babcock, Clarence L., Professor Emeritus of Optical Sciences
Babich, George, Assistant Professor of Secondary Education
Bacvarov, Dosio C., Associate Professor of Electrical and Computer Engineering
Bagnara, Joseph Thomas, Professor of Ecology and Evolutionary Biology
Bahill, Andrew T., Professor of Systems and Industrial Engineering
Bailey, Daniel Edgar, Professor of Statistics and Computer Science
Bailey, Don Clifford, Professor of Oriental Studies
Baker, Boyd Byron, Associate Professor of Exercise and Sport Sciences
TEACHING AND RESEARCH FACULTY

Baker, Gregory R., Associate Professor of Mathematics
Baker, Robert Lewis, Associate Professor of Systems and Industrial Engineering
Baker, Victor R., Professor of Geosciences
Balch, Philip, Associate Professor of Psychology
Baldessari, Bruno, Professor of Statistics
Bales, Roger, Assistant Professor of Hydrology and Water Resources Administration
Balser, Thomas F., Associate Professor of Aerospace and Mechanical Engineering
Balter, Paul Anthony, Professor of Military Science
Bamford, Colin R., Assistant Professor of Neurology
Banner, William, Jr., Assistant Professor of Pediatrics
Bannister, Bryan, Professor of Dentistry and Systematics
Barbee, Robert, Professor of Internal Medicine
Bartfield, Russell Morris, Professor of Accounting
Barfield, Michael, Professor of Chemistry
Barham, Terry J., Associate Professor of Music
Barker, Adele Marie, Associate Professor of Russian and Slavic Languages
Barlow, David Lane, Associate Professor of Agricultural Economics
Barlow, William Donald, Professor Emeritus of Secondary Education
Barreca, Frank R., Professor Emeritus of Radio-TV Film Production
Barrett, Bruce Richard, Professor of Physics
Barrett, Harrison H., Professor of Radiology and Optical Sciences
Barrett, William Bernard, Professor of Accounting
Barreuther, Alan D., Associate Professor of Pharmacy Practice
Barrow, Lee, Assistant Professor of Spanish and Portuguese
Bartels, Paul George, Professor of Plant Sciences
Bartels, Peter Hans, Professor of Pathology and of Optical Sciences
Bartlett, Neil Riley, Professor Emeritus of Psychology
Bashkin, Stanley, Professor of Physics
Basso, Ellen Becker, Professor of Anthropology
Battman, Herman E., Professor Emeritus of History
Bates, Robert Brown, Professor of Chemistry
Battan, Louis Joseph, Professor of Atmospheric Sciences
Bauwens, Eleanor Eustice, Professor of Nursing
Bechtel, Robert B., Professor of Psychology
Beck, Jean, Professor Emeritus of German
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Belcheff, Koate Alexander, Associate Professor of Music
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Beutler, Larry E., Professor of Psychiatry
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Dawson, George Albert, Professor of Atmospheric Sciences
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de la Foux, Roger Alain, Associate Professor of History
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Doxtater, Dennis Charles, Associate Professor of Architecture
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Drach, George Wisse, Professor of Surgery
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Dulle, John W. F., Professor of History
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Dunkel, Alexander, Associate Professor of Russian and Slavic Languages
Durant, William J., Assistant Professor of Ophthalmology
Durla, Brian G. M., Professor of Internal Medicine
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Dye, Fred Arthur, Associate Professor of English
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Eastoe, Christopher John, Assistant Professor of Geosciences
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Edwards, Irene F., Assistant Professor of Internal Medicine
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Enemark, John Henry, Professor of Chemistry
Enke, Fred, Professor Emeritus of Health, Physical Education and Recreation
Enoka, Roger Maro, Assistant Professor of Exercise and Sport Sciences
Entice, Wayne Edward, Associate Professor of Art
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Erickson, Maynard Lindsey, Professor of Sociology
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Ervin, Elizabeth Zinn, Associate Professor of Music
Ervin, Thomas, Associate Professor of Music
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Evans, Gilbert Edward, Associate Professor of Spanish and Portuguese
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Ewbank, Henry Lee, Professor of Speech Communication
Ewy, Gordon A., Professor of Internal Medicine
Fagan, Timothy Charles, Assistant Professor of Internal Medicine
Fahey, Shirley Nikolais, Assistant Professor of Psychiatry
Fahey, Walter John, Professor of Electrical and Computer Engineering
Fairchild, Patricia Cartette, Associate Professor of Exercise and Sport Sciences
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Falco, Charles Maurice, Professor of Physics
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Fan, Chang-Yun, Professor of Physics
Fan, Paula, Assistant Professor of Music
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Fernandez, Celestino, Assistant Professor of Sociology
Fernandez, Roberto M., Assistant Professor of Sociology
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Goodman, Seymour, Professor of Management Information Systems
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Hamilton, Douglas James, Professor of Electrical and Computer Engineering
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Hartwell, Onnie Michael, Professor Emeritus of Music
Hartshorne, David J., Professor of Nutrition and Food Science and of Biochemistry
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Haswell, Jeffrey Robert, Associate Professor of Music
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Lucas, David O., Associate Professor of Microbiology and Immunology
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McClore, Craig L., Assistant Professor of Family and Community Medicine
### TEACHING AND RESEARCH FACULTY

<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>McClure, Michael A.</td>
<td>Professor of Plant Pathology</td>
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<tr>
<td>McConnell, Robert Eastwood</td>
<td>Professor of Architecture</td>
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<td>McCord, Beverly Ann</td>
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<td>McCormick, Floyd Guy, Jr.</td>
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<td>McCoy, Leahmae</td>
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<td>McCracken, Betty Jo</td>
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<td>McCullen, John D.</td>
<td>Professor of Physics</td>
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<td>McCullough, Edgar J., Jr.</td>
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<td>McDaniel, Robert Gene</td>
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<td>McEligot, Donald Marinus</td>
<td>Professor of Aerospace and Mechanical Engineering</td>
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<td>McElroy, Douglas Keith</td>
<td>Associate Professor of Art</td>
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<td>McElroy, John Harmon</td>
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<td>McGhan, William Frederick</td>
<td>Associate Professor of Pharmacy Practice</td>
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<td>McGinnies, William Grovenor</td>
<td>Professor Emeritus of Dendrochronology</td>
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<td>McGrew, Bruce Elwin</td>
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<td>McIlff, Lyle Hatch</td>
<td>Professor of Accounting</td>
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<td>McIntyre, Kenneth Earl</td>
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<td>McIntyre, Laurence Cook, Jr.</td>
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<td>Mc Kelvie, Douglas Hugh</td>
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<td>Melnik, Amelia</td>
<td>Professor of Reading</td>
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<td>Professor Emeritus of Metallurgical Engineering</td>
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Niles, Marcia S., Assistant Professor of Accounting
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Patchett, Peter J., Associate Professor of Geosciences
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Pearson, Jack W., Professor of Obstetrics and Gynecology
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Penner, Jonathan David, Associate Professor of English
Pepper, Ian L., Associate Professor of Soils, Water and Engineering
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Perkins, Henry Crawford, Jr., Professor of Aerospace and Mechanical Engineering
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Rodney, D. Ross, Professor Emeritus of Plant Sciences
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Rogers, Willard Lewis, Professor Emeritus of Aerospace and Mechanical Engineering
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Rossa, Rosemary Anne, Associate Professor of Educational Psychology
Rubis, David Daniel, Professor of Plant Sciences
Rudd, Joel, Associate Professor of Family and Consumer Resources
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Sabers, Darrell Lee, Professor of Educational Psychology
Sacamano, Charles Michael, Professor of Plant Sciences
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Saldenha, Fernando (Mauricio Caldeira Brant), Assistant Professor of Economics
Sales, Darrel Lee, Professor of Educational Foundations and Administration
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Sallaba, Bonnie, Assistant Professor of Agricultural Economics
Salmon, Sydney Elias, Professor of Internal Medicine
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Schlossa, Gerd Tobias, Professor Emeritus of Microbiology and Medical Technology
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Sheehan, Edward T., Associate Professor of Nutrition and Food Science
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Sheppy, Charles Evan, Associate Professor of English
Shepherd, Michael Donn, Associate Professor of Accounting
Shimizu, Nobuyoshi, Associate Professor of Molecular and Cellular Biology
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Simko, Derreil G., Associate Professor of Exercise and Sport Sciences
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Sinclair, Norval Arthur, Associate Professor of Microbiology and Immunology
Sinskey, James Thomas, Associate Professor of Microbiology and Immunology
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Stanfield, Alice Borden, Professor Emerita of Nutrition and Food Science
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Stanielc, Thomas H., Associate Professor of Surgery
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Steele, Susan Myrtle, Professor of Linguistics
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and Professor of Internal Medicine
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Stith, Lee S., Professor Emeritus of Plant Sciences
Stock, Gregory M., Assistant Professor of Military Science Tactics
Stockman, Lynn Homer, Professor Emeritus of Marketing
Stockton, Charles Wayne, Professor of Dendrochronology
Stokes, Maraden B., Professor Emeritus of Educational Foundations and Administration
Stokes, Marvin Allen, Professor of Dendrochronology
Stone, Herbert Reynolds, Associate Professor of Spanish and Portuguese
Stoner, John Oliver, Jr., Professor of Physics
Stott, Gerald H., Professor Emeritus of Animal Science
Stouffer, Richard Lee, Associate Professor of Physiology
Strack, David, Professor of Exercise and Sport Sciences
Streitmatter, Janice Lynn, Assistant Professor of Secondary Education
Strickland, Robin N., Assistant Professor of Ecology and Evolutionary Biology
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Stuart, Douglas Gordon, Professor of Physiology
Stubblefield, Thomas Mason, Professor Emeritus of Agricultural Economics
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Sundareshan, Malur K., Associate Professor of Electrical and Computer Engineering
Svob, Robert Stanley, Professor Emeritus of Physical Education and Dean Emeritus of Students
Swalin, Richard, Professor of Materials Science and Engineering
Swanson, Gerald John, Assistant Professor of Economics
Swearingen, C. Jan, Assistant Professor of English
Swenson, Charles W., Assistant Professor of Accounting
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Swisher, Linda, Associate Professor of Speech and Hearing Sciences
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Taussig, Lynn Max, Associate Professor of Pediatrics
Taylor, B. Brooks, Professor of Plant Sciences
Taylor, Bruce Ross, Professor Emeritus of Animal Science
Taylor, Carol A., Assistant Professor of Economics
Taylor, Lester D., Professor of Economics
Terweaki, Frank W., Assistant Professor of Dendrochronology
Teppling, Ronnie H., Associate Professor of French and Italian
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Trejo, Arnulfo Duenas, Professor Emeritus of Library Science
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Van Asdall, Willard, Associate Professor of Ecology and Evolutionary Biology
Van de Voorde, Ronald Andre, Associate Professor of Library Science
Van Metre, Patricia, Associate Professor of Speech Communication
Van Ort, Emily S., Associate Professor of Nursing
Van Reusen, Anthony, Assistant Professor of Special Education
Van Slyck, Willard Nicholas, Jr., Professor Emeritus of Law
Van Wyck, David Bicknell, Assistant Professor of Internal Medicine
Vavich, Mitchell George, Professor Emeritus of Nutrition and Food Science
Velez, William Yslas, Associate Professor of Mathematics
Velez-Ibanez, Carlos Guillermo, Associate Professor of Anthropology
Vemulapalli, G. Krishna, Associate Professor of Chemistry
Venable, David Lawrence, Assistant Professor of Ecology and Evolutionary Biology
Verran, Joyce Ann, Assistant Professor of Nursing
Vignery, John Robert, Professor of History
Villar, Hugo V., Professor of Surgery
Vincent, Thomas Lange, Professor of Aerospace and Mechanical Engineering
Vleck, David Joseph Alan, Assistant Professor of Ecology and Evolutionary Biology
Vogel, Ronald Joseph, Associate Professor of Management and Policy
Voigt, Robert Lee, Professor of Plant Sciences
Volgy, Thomas John, Associate Professor of Political Science
Volz, Robert George, Professor of Surgery
Vuillemin, Joseph J., Professor of Physics
Vuono, Anthony, Professor of Family and Community Medicine
Wacks, Morton E., Professor of Nuclear and Energy Engineering
Wade, James C., Associate Professor of Agricultural Economics
Wagle, Robert Ray, Professor of Watershed Management
Wahlke, John C., Professor of Political Science
Wait, James R., Professor of Electrical and Computer Engineering
Wait, John Vary, Professor of Electrical and Computer Engineering
Walker, H. Todd, Professor of Art
Wallendorf, Melanie Ruth, Associate Professor of Marketing
Walller, William Stites, Assistant Professor of Accounting
Wallraff, Charles F., Professor Emeritus of Philosophy
Wang, Yng-Yuh R., Assistant Professor of Management Information Systems
Wangeneeot, Stephen L., Professor of Surgery
Wangness, Roald Klinkenberg, Professor of Physics
Warburton, Jeffrey Lynn, Associate Professor of Drama
Ward, Oscar G., Associate Professor of Ecology and Evolutionary Biology
Ware, George Whitaker, Jr., Professor of Entomology
Warrick, Arthur Will, Professor of Soils, Water and Engineering
Watson, Theo Franklin, Professor of Entomology
Watts, Raymond Ellsworth, Professor Emeritus of Veterinary Science
Wearing, John Peter, Professor of English
Weaver, Albert Bruce, Professor Emeritus of Physics and Executive Vice President
Weaver, Thomas, Professor of Anthropology
Weber, Charles Walter, Professor of Nutrition and Food Science
Weimer, E. Sue, Assistant Professor of Management Information Systems
Weber, Jean Draper, Professor of Statistics and of Management and Policy
Weiner, Sheldon A., Assistant Professor of Obstetrics and Gynecology
Weinstein, Donald, Professor of History
Weinstein, Louis, Associate Professor of Obstetrics and Gynecology
Weiss, Barry David, Assistant Professor of Family and Community Medicine
Weldon, Roger Jonathan, Professor Emeritus of Systems and Industrial Engineering
Wells, Donald A., Professor of Economics
Wells, Michael Arthur, Professor of Biochemistry
Welty, Mary Jane, Associate Professor of Nursing
Wendt, Jost Otto Lutz, Professor of Chemical Engineering
Werner, Floyd Gerald, Professor of Entomology
Werner, Robert Joseph, Professor of Music
Wert, James Edward, Professor of Finance and Real Estate
West, Charles W., Associate Professor of Music
West, Stephen Harry, Professor of Oriental Studies
Westbrook, Robert Arthur, Professor of Marketing
Westerman, Bryan R., Associate Professor of Radiology and Radiation Safety
Wetzal, Mary C., Professor of Psychology
Wexler, David B., Professor of Law
Weymann, Ray John, Professor of Astronomy
Wheeler, Lawrence, Professor of Psychology
White, Donald Henry, Professor of Chemical Engineering
White, Howard Dwaine, Assistant Professor of Biochemistry
White, Raymond E., Jr., Associate Professor of Astronomy
White, Simon D., Associate Professor of Astronomy
Whiting, Allen S., Professor of Political Science
Whiting, Frank M., Professor of Animal Science
Whooley, Douglas R., Assistant Professor of Management and Policy
Wieland, John H., Professor Emeritus of Marketing
Wierama, Frank, Professor of Soils, Water and Engineering
Wild, Peter Thomas, Professor of English
Wilhelm, Mari Sue, Assistant Professor of Family and Consumer Resources
Wilkenning, Laurel Lynn, Associate Professor of Planetary Sciences
Wilson, Donovan, Associate Professor of Landscape Architecture
Willard, Thomas Spaulding, Assistant Professor of English
Williams, David Allen, Associate Professor of Speech Communication
Williams, Edward Jerome, Professor of Political Science
Williams, Jean Marie, Associate Professor of Exercise and Sport Sciences
Williams, Norman, Professor of Geography and Regional Development
Williams, Rickey L., Assistant Professor of Pediatrics
Williams, Robert Eugene, Professor of Astronomy
Williams, Theodore L., Associate Professor of Electrical and Computer Engineering
Williamson, Jeffrey F., Assistant Professor of Radiology
Wilksa, Alvar P., Professor of Physics
Wilson, Clifton E., Professor of Political Science
Wilson, George Spencer, Professor of Chemistry
Wilson, Herbert Blair, Professor Emeritus of Educational Foundations and Administration
Wilson, John Michael, Professor of Dance
Wilson, Paul Nicholas, Assistant Professor of Agricultural Economics
Wilson, William Jerram, Associate Professor of Oriental Studies
Wimmer, Gayle Ellen, Associate Professor of Art
Wing, William Hinshaw, Professor of Physics and Optical Sciences
Winslow, Dianne Joan, Assistant Professor of Drama
Wirsching, Paul Hugh, Professor of Aerospace and Mechanical Engineering
Wise, Edward Nelson, Professor Emeritus of Chemistry
Wise, Mark E., Assistant Professor of Animal Sciences
Witkowski, James M., Assistant Professor of Civil Engineering and Engineering Mechanics
Witte, Charles Lionel, Professor of Surgery
Witte, Marilyn Hearst, Professor of Surgery
Wolf, Gerrit, Professor of Management and Policy
Wolfe, William Louis, Jr., Professor of Optical Sciences
Wolff, Mary K., Assistant Professor of Dance
Woolshin, David Jordan, Professor Emeritus of German
Wood, Bruce, Associate Professor of Mathematics
Wood, Elwin Grant, Professor Emeritus of Marketing
Wood, Mary Adele, Professor Emeritus of Home Economics
Woodard, Dudley B., Jr., Adjunct Associate Professor of Higher Education
Woods, Alexander Hamilton, Associate Professor of Internal Medicine
Woods, David G., Professor of Music
Woods, Winton deRuyter, Jr., Professor of Law
Woodill, Margaret A., Assistant Professor of Nursing
Woolf, Neville John, Professor of Astronomy
Woolfenden, James Manning, Professor of Radiology
Worthen, Thomas De Voe, Associate Professor of Classics
Wortman, Robert Hilton, Associate Professor of Civil Engineering and Engineering Mechanics
Wrenn, Robert La Raut, Professor of Psychology
Wright, Arthur Larry, Associate Professor of Mathematics
Wright, Stephen Henry, Assistant Professor of Physiology
Wyant, James C., Professor of Optical Sciences
Wymore, A. Wayne, Professor of Systems and Industrial Engineering
Yakovitz, Sidney, Professor of Systems and Industrial Engineering
Yalkowsky, Samuel H., Professor of Pharmaceutical Sciences
Yall, Irving, Professor Emeritus of Microbiology
Yamamura, Henry Ichiro, Professor of Pharmacology and of Biochemistry and Associate Professor of Psychiatry
Yang, Peter J., Assistant Professor of Radiology
Yappel, A. Ralph, Professor Emeritus of Aerospace and Mechanical Engineering
Yates, Alayne, Professor of Psychiatry
Yitayew, Muluneh, Assistant Professor of Soils, Water and Engineering
Yoffee, Norman, Associate Professor of Anthropology
Yoshino, I. Roger, Professor of Sociology
Young, Elizabeth B., Associate Professor of Counseling and Guidance
Young, Katherine Jean, Associate Professor of Nursing
Young, Kenneth Christie, Associate Professor of Atmospheric Sciences
Young, Richard A., Associate Professor of Physics
Young, Richard P., Assistant Professor of Range Management
Young, S. Mark, Assistant Professor of Accounting
Younggren, Newell Amos, Professor of Ecology and Evolutionary Biology
Zagona, Salvatore Vincent, Professor Emeritus of Psychology
Zajac, Edward, Professor of Economics
Zapotocky, Joseph A., Professor Emeritus of Pharmaceutical Sciences
Zagura, Stephen L., Associate Professor of Anthropology
Zube, Ervin H., Professor of Renewable Natural Resources
Zukoski, Charles Frederick, III, Professor of Surgery
Zukowski/Faust, Jean, Associate Professor of English
Zumbro, Nicholas L., Professor of Music
Zurbrick, Phillip Raymond, Associate Professor of Agricultural Education
Zwinger, Lynda M., Assistant Professor of English
Zwolinski, Malcolm John, Professor of Watershed Management
**General Information**

The pursuit of truth and the extension of knowledge are well-recognized goals of most American universities. At the University of Arizona, the Graduate College is the major administrative unit through which these dual purposes are achieved. 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.

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 on Graduate Study is primarily responsible for maintaining proper standards and developing graduate programs.

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 is 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.

**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 of 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.

**FACILITIES AND SERVICES**

The University of Arizona offers graduate programs in more than 100 departments and fields, each supported by well-trained faculty and well-equipped physical resources. Departments offering advanced degree programs have excellent teaching and research facilities. Additionally, certain facilities and services of exceptional importance are available to advanced students. Some state of Arizona research and service agencies have been affiliated with the University of Arizona since their inception. Many facilities are interdepartmental and may be significant to graduate students from several fields.

**AGRICULTURAL EXPERIMENT STATION** — One of the divisions of the College of Agriculture, the Arizona Agricultural Experiment Station is responsible for the research program in agriculture, renewable natural resources, and family and consumer resources. The research activities within the college are administered by the Director of the Experiment
Station. Broad in scope, the program includes both basic and applied research in nearly every department. Modern facilities for both laboratory and field research are available on the University campus as well as at agricultural centers throughout the state of Arizona. 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 Experiment Station maintains close cooperative relationships with research agencies such as the Agricultural Research Service and the Forest Service of the United States Department of Agriculture.

Research assistantships are available in most of the departments in the Experiment Station. The graduate student is frequently an important member of an Experiment Station research project, sharing in the use of laboratory and field facilities as well as having the opportunity to work under the guidance of senior scientists of national and international reputation.

The ANIMAL DISEASE DIAGNOSTIC SERVICE was initiated by the Department of Veterinary Science in 1934 and has provided continuous service to the animal owners of Arizona since its establishment. Administered under the Agricultural Experiment Station, diagnostic services are provided upon referral from private veterinary practitioners for any resident of the state.

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.

ARIZONA CENTER FOR EDUCATIONAL RESEARCH AND DEVELOPMENT (1971) initiates and conducts research and development programs in such areas as early childhood education, teaching and learning, language and literacy, cultural diversity and learning, and education of exceptional children. The center provides faculty and graduate students with the following support services: grant proposal development; weekly notices of funding sources; computer allocations for research and instruction; funding for small projects; and budget review and negotiation assistance.

ARIZONA COOPERATIVE FISHERY RESEARCH UNIT — The functions of the Arizona Cooperative Fishery Research Unit are those of graduate education, research, and extension. The unit is supported by the University of Arizona, the Arizona Game and Fish Department, and the U.S. Fish and Wildlife Service. The research program is directed chiefly toward learning how to meet the rapidly increasing demand for inland sport fishing opportunities. Both graduate students and staff participate in this effort. The unit is housed in the School of Renewable Natural Resources.

The ARIZONA COOPERATIVE NATIONAL PARK RESOURCES STUDY UNIT, 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 COOPERATIVE WILDLIFE RESEARCH UNIT is sponsored and supported jointly 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 wildlife biology.
Arizona affords unusual opportunities for research on game and management problems because of the large variety of game species native to the state and the wide diversity of habitats. The unit is housed in the School of Renewable Natural Resources.

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 anyone in the state. It also offers drug information and therapeutic consultations to health professionals. The center has a toll-free telephone number (listed on the inside cover of Arizona telephone directories) 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 a medical toxicologist and specialists in plant and animal poisons, drugs, and environmental and industrial poisons. The Arizona Poison and Drug Information Center provides for clinical training of pharmacy students in the areas of drug and poison information. The Arizona Poison and Drug Information Center is a component of the Arizona Poison Control System which was established by the Arizona State Legislature in 1980 and is based in the College of Pharmacy. 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) is the 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 a computer system 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 as a territorial museum in 1893, is an educational, research, and service division of the University. Prehistoric and recent Indian cultures of Arizona and the Southwest are interpreted through permanent exhibitions. Collections number more than 150,000 specimens, including those of the Gila Pueblo Archaeological Foundation. The close association of the Museum with the Department of Anthropology makes it possible for qualified graduate students to use the collections in research and to participate in the Museum’s field projects. Museum personnel teach in the Department of Anthropology, especially in the museology and cultural resource management specialties. The State Museum is open daily to the public; it is closed on major holidays.

The BOYCE THOMPSON SOUTHWESTERN ARBORETUM is operated cooperatively by the University of Arizona College of Agriculture, Arizona State Parks Board, and the Boyce Thompson Southwestern Arboretum, Inc. 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, 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.

The **BUREAU OF GEOLOGY AND MINERAL TECHNOLOGY** is charged with developing, maintaining, and disseminating to the people of Arizona information relating to mining, metallurgy, and earth sciences generally. Its scientific investigation and public service activities are comparable to those conducted by geological agencies and mineral experiment stations in other states.

The close union of the Bureau with the teaching programs of the College of Mines and the Department of Geosciences has been exceptionally productive in the development and dissemination of knowledge about the mineral resources of Arizona.

The Bureau is a member of the Association of American State Geologists, the national affiliation of geological surveys of individual states.

The **CENTER FOR CREATIVE PHOTOGRAPHY** (1975), a division of the University Library, is a growing research library and archive containing material on all aspects of photography. The collection includes rare photographic books, periodicals, photographs, and manuscript collections, as well as the archives of major American photographers and a large collection representing over 1500 photographers. In addition, the Center sponsors a lecture series and frequent exhibitions and publishes a journal entitled *The Archive*. Photographs not on exhibition may be viewed by appointment.

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 also provides graduate-level instruction leading to master's and doctoral degrees.

The **COOPERATIVE EXTENSION SERVICE** (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 sciences, youth development (4-H), and rural development. The Service 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 CONTINUING EDUCATION**, as an academic division of the university, provides off-campus daytime and evening credit courses as well as various special-interest courses and community programs on and off the campus. Students desiring graduate credit for off-campus graduate-level courses offered through continuing education must first be admitted to the Graduate College on regular or unclassified graduate status. Also, students desiring graduate credit should be certain that the particular section of the course for which the student intends to register has been authorized as available for graduate credit. Off-campus graduate courses carry university credit, which may be applied toward graduate degree programs where appropriate, but no student may later apply toward an advanced degree more than six units earned as an unclassified graduate student. Graduate students should confer with their advisers and the Graduate College regarding the applicability of continuing education and university extension courses to their programs.

The **DIVISION OF ECONOMIC AND BUSINESS RESEARCH** 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, public policy and planning; to facilitate the publication of research by faculty and staff; and to disseminate information. To achieve its objectives the Division conducts research, both sponsored and unsponsored, publishes
GENERAL INFORMATION

the semiannual Arizona Review, the monthly Arizona's Economy, and the chart book Arizona Economic Indicators, as well as monographs and special studies, and conducts both forums and seminars for the public. In addition, the Division answers requests from business, government, and the general public for tabular information and, as a member of the State Data Center, for computerized census information.

The DIVISION OF MEDIA AND INSTRUCTIONAL SERVICES (1939) provides a wide range of instructional media, production, research, and public broadcasting services to the University, community, and state. The division operates three maximum-power public broadcasting stations: KUAT-TV (Channel 6 and Translator Channel 71), KUAT-AM (1550 kHz), and KUAT-FM (90.5 MHz and Translator Frequency 89.5 MHz). Professional production facilities are maintained in the Modern Languages Building, the Audiovisual Building, the Harvill Building, and the Arizona Health Sciences Center. Production capability includes color studio and mobile television, and 16mm motion picture equipment. The stations are affiliated with the Public Broadcasting Service (PBS) and National Public Radio (NPR).

The Microcampus produces and distributes University courses to business and industry in the Tucson area through a two-channel interactive Educational Television System (IETS) and throughout the nation by video tape.

The Instructional and Research and Development area is committed to improving the quality of instruction at the University. Members of the staff consult with members of the faculty in course design and revision. The staff holds workshops for interested University personnel and provides an ongoing evaluation of teaching effectiveness.

The Graphics Center provides outstanding graphic and photography services to the University.

The Film Library and Equipment Services provide media and audiovisual materials to both the University and other educational institutions.

Many members of the division staff serve as faculty members.

ENGINEERING EXPERIMENT STATION — As a part of the College of Engineering, the Experiment Station pursues a research program in a variety of areas of engineering, including solar energy, microelectronics, interactive computational mechanics, biophysics technology, digital image analysis, and nuclear fuel cycles. Through research assistantships, the station provides support and research opportunities for qualified graduate students. Also, the station provides research management services for investigators and promotes interdisciplinary programs.

The ENVIRONMENTAL RESEARCH LABORATORY (1967) conducts research in controlled-environment agriculture (CEA) for intensive food production, in seawater crop irrigation, and in solar heating and cooling. ERL has designed CES vegetable systems which produce crops in the desert sands of the United States, Mexico and 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 GRACE H. FLANDRAU 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 planetary science that take audiences on cosmic journeys through time and space. The science exhibit halls and 16-inch telescope are open free to the public. Open daily; theatre dark Mondays.

The HUMAN DEVELOPMENT LABORATORY (1979) is an interdisciplinary research and training center within the Division of Child Development and Family Relations in the School
of Family and Consumer Resources. The laboratory is charged with promoting and conduct-
ing applied research to enhance the welfare of families and individuals. The laboratory
supports and conducts funded and nonfunded research on issues relating to all stages of
human life. Priority is given to research that is interdisciplinary, preventive, and issue-or-
ented. The facility is equipped for audio and video taping and sponsors colloquiums and a
semiannual newsletter.

The **INSTITUTE OF ATMOSPHERIC PHYSICS** is a research organization placing particular
emphasis on the study of aerosols, clouds and precipitation, atmospheric electricity, modell-
ing of global climate, atmospheric dynamics, radiation processes, remote sensing, and
atmospheric chemistry.

Undergraduate and graduate student instruction is accomplished primarily through
the Department of Atmospheric Sciences.

The **JEFFREY M. GOLDING CLINICAL RESEARCH UNIT (1984)** of the College of Pharmacy
is a two-bed, specially equipped facility located on the third floor of the college's new
building. The primary objective of the unit 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 unit consists of three rooms including a
private office for conducting patient interviews or preliminary examinations, a patient wait-
ning room and the main facility housing two hospital beds with cardiac monitors, two blood
drawing chairs and a dual reading scale.

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 Admin-
istration. It has three broad objectives: (1) to promote research in basic market processes,
(2) to sponsor an Entrepreneurial Studies Program for seniors and MBA students, 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
fellows are also available. The Entrepreneurial Studies Program offers both academic
courses for students interested in entrepreneurship and practical courses on the develop-
ment of business plans. Approximately 35 students are included in the program annually.
Business/academic exchange occurs through an annual dialogue on significant national
economic issues and through semiannual new venture forums where entrepreneurs present
business plans.

The **LABORATORY OF TREE-RING RESEARCH** was organized in 1937 as 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 establish-
ment of new tree-ring chronologies throughout the world, the understanding of basic tree-
growth and environmental relationships, the reconstruction of paleohydrologic and pal-
eoclimatic 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 **LUNAR AND PLANETARY LABORATORY** is the research institute allied with the Planetary
Sciences Department. The Laboratory research staff includes members of the depart-
ment as well as those holding research appointments in the Lunar and Planetary Laboratory.
The Laboratory is housed in the Gerard P. Kuiper Space Sciences Building, in close prox-
imity to the Optical Sciences Center and the Kitt Peak National Observatory, as well as the
Steward Observatory and Astronomy Department, with which close working relationships
are maintained.
Laboratory staff engage in research and graduate instruction over a wide range of planetary, space, and terrestrial science. Some of the areas of present scientific activity are experimental and theoretical geochemistry, geophysics, lunar and planetary geology, spacecraft imaging of planetary surfaces and rings, the physics of planetary interiors; cosmic rays, the solar wind, cosmical plasmas and magnetohydrodynamics, polarimetry, infrared Fourier spectroscopy, planetary atmospheres, solar physics, asteroid and comet research, ultraviolet space astronomy, optical astronomy, and studies of the origin of the solar system. Much of the research at the Lunar and Planetary Laboratory is closely associated with the NASA space science program, including numerous lunar, planetary, and Earth-orbital missions. Several faculty of the Department and the Laboratory have been principal or co-investigators on space experiments including Apollo, Mariner, Voyager, Space Telescope and Pioneer spacecraft, as well as several international spacecraft missions.

Major ground-based research facilities include the University of Arizona telescopes (150 cm, 100 cm, 70 cm aperture reflectors on Mt. Lemmon; 154 cm aperture reflector and 46/71 cm Schmidt camera near Mt. Bigelow; 53 cm reflector on Tumamoc Hill; 220 cm Cassegrain reflector in Kitt Peak; and the multiple-mirror telescope on Mt. Hopkins); a scanning electron microprobe laboratory, a neutron activation analysis laboratory, and the Space Imagery Center. In addition, the Laboratory conducts high-altitude observational programs for solar, planetary, and stellar infrared spectroscopy using NASA jet aircraft. A full complement of computational facilities, and other technical support, is available to the research programs; the University has access, thorough a national consortium, to a large super-computer.

The Laboratory sponsors a regular series of scientific colloquia and seminars, and frequently is host to visitors from other scientific institutions around the world. Graduate research assistantships are available on a selected basis to students planning to study toward the Ph.D. degree with a major in planetary sciences.

MICROCAMPUS (1972) is an education delivery system which uses video cassettes and live, interactive microwave transmission to make University of Arizona classes available to students throughout the U.S. Students in remote locations who want University credit must be admitted to the University and register for classes in absentia. Successful completion of a course results in a University credit transcript entry. In addition to regular courses, videotaped short courses provide up-to-date information on diverse subjects, but are not available for University credit. Developed in the College of Engineering, Microcampus has grown to include courses from many other colleges and is now part of the Division of Media and Instructional Services.

The MINERAL MUSEUM (1919) emphasizes Arizona's unique mineral heritage in a spectacular collection of minerals, fossils, and gems. The Museum, a part of the collections of the Department of Geosciences since its establishment, is open to students and the general public.

NUCLEAR REACTOR — The TRIGA reactor in the Department of Nuclear and Energy Engineering is both a training and a research facility. The uranium-zirconium hydride-fueled, pool-type reactor is conveniently designed for the study of many research problems in reactor engineering, including those of variation in core geometry, shielding, neutron behavior, transient characteristics, and control.

The reactor operates at an average power level of 100 kilowatts with a thermal neutron flux of approximately 2 x 10^{12} neutrons per square centimeter per second. Operation in the pulse mode with peak power levels up to 680 Mw and pulse widths of about 17 milliseconds is also available.

The reactor is available for research to all departments of the University for neutron irradiation services. Objects of large size may be encased and lowered to the top of the reactor core for exposure to neutrons. Smaller samples may be placed directly in a fast neutron irradiation facility or in one of the forty thermal neutron exposure positions available.

A pneumatic sample irradiation facility is available for research with short-lived radioactive materials, and external neutron beams may be used for neutron radiography. A variety of gamma ray spectroscopy equipment is available to allow full use of the activation analysis capabilities of the reactor.
OFFICE OF ARID LANDS STUDIES — Administratively located in the College of Agriculture, this office serves as the coordinating agency among the many University departments and colleges engaged in arid lands research. This cooperative relationship is a natural outgrowth of the institution's traditional and historic concern with the physical, biological, and social environment of arid lands. The office administers the interdisciplinary doctoral program in arid lands resource sciences. This degree program offers an opportunity for the qualified, mature student to make an outstanding contribution toward understanding and solving the worldwide problems of the arid zones.

Additionally, the Office of Arid Lands Studies undertakes special studies under grants and contracts, issues bibliographical and scientific publications, and, as a clearinghouse for the exchange of world arid lands information, maintains liaison with all international bodies and foreign institutions concerned with arid zone problems.

The OPTICAL SCIENCES CENTER is a graduate center for research in applied and theoretical optical physics, and students may undertake graduate programs leading to the M.S. and Ph.D. degrees. Areas in which research is currently being conducted include atmospheric optics, coherent optics, holography, image processing, infrared techniques, integrated optics, laser physics, medical optics, modulation spectroscopy, optical design, optical fabrication and testing, optical properties of materials, quantum optics, remote sensing, solar energy, and thin-film technology. In addition, interdisciplinary research programs involving the Departments of Astronomy, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Mathematics, Microbiology and Immunology, Physics, Physiology, Planetary Sciences, Psychology and Radiology are in progress.

Special facilities of the Optical Sciences Center include an electronics shop, faculty/student machine shop, instrument shop, massive-optics shop, small-optics shop, photographic dark rooms, PDS microdensitometer, eclipse minicomputer, remote computer terminal, reading room, teaching laboratory, and thin-film facility. These facilities are often used by graduate students in their research programs.

The RUTH E. GOLDING CLINICAL PHARMACOKINETICS LABORATORY (1977) in the College of Pharmacy is primarily an analytical laboratory where new assays are developed to quantify drugs and their metabolites from biological fluids. These assays are used in conjunction with animal and clinical research projects to better define the disposition of and response to drugs. The results of these studies along with the monitoring of drug plasma concentrations in patients are used to optimize therapy by individualizing drug administration.

The SOUTHWEST CENTER (1982) is a University unit which seeks to encourage and facilitate teaching, research, and the dissemination of information related to the history, culture, and ecology of the Mexican Northwest and U.S. Southwest. The Center is affiliated with the Universidad Nacional Autonoma de Mexico, U.N.A.M. 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.

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.

The STEWARD OBSERVATORY was established in 1916 by the generous gift of Lavinia Steward in honor of her husband, George Steward. For many years, the Observatory's principal telescope was its 36-inch (91-cm.) reflector, constructed with the aid of the Steward bequest.
The primary research telescopes of the Observatory now include the Multiple Mirror Telescope (MMT), located on the Mt. Hopkins summit in the Santa Rita Mountains, the 90-inch (2.3-m.) Ritchey-Chretien reflector at the Kitt Peak site, and the 61-inch (1.55-m.) Cassegrain reflector at the Mt. Bigelow station in the Santa Catalina Mountains. The MMT, operated jointly with the Smithsonian Astrophysical Observatory, represents an innovative and successful concept for construction of large optical telescopes; it may thus become the prototype for future large-aperture telescopes. The major telescopes are used with a wide variety of instrumentation and detectors and are supported by several smaller instruments used for teaching or special research projects.

The Steward Observatory offices and laboratories are located on the University campus adjacent to the original 36-inch dome, which now houses a 21-inch instructional telescope. The main areas of research at the Observatory include extragalactic and galactic astronomy, with specializations in the areas of quasars, star formation, interstellar medium, degenerate stars, infrared sources, novae, and radio galaxies. Observational work is concentrated in the optical and infrared but includes work at radio, ultraviolet, and x-ray wavelengths using other facilities. The Observatory is developing a 10-meter class telescope for work at mm and sub-mm wavelengths in collaboration with the Max Planck Institute for Radioastronomy in Bonn, West Germany. The research programs also include a wide range of theoretical studies in modern astrophysics.

The administrative offices and laboratories of the Kitt Peak National Observatory are across the street from the Steward Observatory and the offices of the National Radio Astronomy Observatory are located within the Steward Observatory. The observatories co-sponsor a series of weekly professional colloquiums. Steward Observatory also maintains close working ties with the University’s Lunar and Planetary Laboratory, the Department of Planetary Sciences, the Optical Sciences Center, the Physics Department, and the Grace M. Flandrau Planetarium.

The UNIVERSITY ANALYTICAL CENTER was established in response to the increasing need for various segments of the academic community to have access to modern chemical analysis methodology. The Analytical Center provides the University with a centralized system analysis. The facility is available to all University disciplines requiring or desiring to use the University community by providing analytical equipment, analytical advice, methods development, sample analysis, and the training of both technical and nontechnical personnel in various aspects of analytical measurements. In addition, the Analytical Center maintains an active program of both basic and applied analytical research. The research activities provide a means of continuously expanding the Analytical Center capabilities and ensuring that equipment and personnel are kept at "state-of-the-art" levels in various analytical areas.

The UNIVERSITY COMPUTER CENTER provides campuswide services and facilities in support of the instructional, research, and administrative computing needs of the University. The University’s network of shared computers consists of a Control Data Corporation CYBER 175 computer, two Digital Equipment Corporation DECsystem-10 computers, and three VAX-11/780 computers. These computers are interconnected to allow data transfer between systems.

The UCC provides a campuswide data communications facility, the IDX-3000, for interconnection of terminals and computers. Interactive access to the university computers is available 24 hours a day. The Center provides terminal access centers at various locations on campus and dial-up ports for access to the university systems from individual laboratories and offices.

The UCC offers many services to assist users in taking advantage of available computing resources. Services include consulting on the use of the University’s computers and various microcomputers; assistance in user acquisition of computing facilities, communications and networking between user-owned equipment and the University’s systems; computer facility planning and preparation; selection, acquisition, installation of microcomputer hardware and software; mainframe and microcomputer training facilities; programming and applications services; and dissemination of information through user publications, manuals, and program library documentation.
UNIVERSITY LIBRARIES — The University Library system contains more than 5,000,000 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, Spanish and Latin American language and literature, American agriculture, Southwestern Americana, Arizoniana, 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 University Library system consists of the Main Library which houses the Central Reference Department, Government Documents, the Media Center, the Map Collection, and the Current Periodicals, Newspapers, and Microforms Room; the Science-Engineering Library; and the following Branch Collections: the Oriental Studies Collection, the Music Collection, the Center for Creative Photography, the Southwest Folklore Center, and the Library Science Library. Four large but separate library facilities are the College of Law Library, the Architecture Library, the Arizona Health Sciences Center 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 Sciences 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.

GOVERNMENT DOCUMENTS — A regional depository for U.S. government documents; houses almost a million items.

MEDIA CENTER — Houses all the library's non-book materials except microforms and music tapes and records.

MAP COLLECTION — A depository for USGS maps, houses a fully cataloged collection of 130,000 maps on every subject.

CURRENT PERIODICALS, NEWSPAPERS, AND MICROFORMS — Displays current issues of the 5200-plus periodicals received in the Main Library, subscribes to over 150 newspapers and has a collection of microforms which numbers nearly 2 million.

SCIENCE-ENGINEERING LIBRARY — Houses all materials on science and technology; has over 360,000 volumes, over a million microforms, and displays current issues of its 3000-plus periodicals.

MUSIC COLLECTION — Houses the library's collection of 50,000 scores, 26,000 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 FOLKLORE CENTER — Houses musical tapes and manuscript archives of Southwest music and folklore.

LIBRARY SCIENCE LIBRARY — Houses the library's collection of professional library literature in support of the Graduate School of Library Science.

SPECIAL COLLECTIONS — Houses the library's collections of Arizoniana and Southwestern Americana, science fiction, rare books, fine printing, manuscripts, and the University of Arizona archives. The Lecomte du Nouy Memorial Room is located here and preserves the manuscripts and first editions of the works of Pierre Lecomte du Nouy and of other important figures in the history of scientific development.

ORIENTAL STUDIES COLLECTION — Houses books, periodicals and newspapers in the Chinese, Japanese, Arabic, Persian, Hindi, Urdu, Turkish, and other Oriental languages; has over 182,000 items.

LAW LIBRARY — This library now contains over 110,000 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.

HEALTH SCIENCES CENTER LIBRARY — This specialized library, which serves the University Hospital as well as the Colleges of Medicine, Nursing, and Pharmacy, contains over 75,000 cataloged volumes and receives approximately 3,000 serial titles. The collection includes books, journals, and nonprint materials in the health sciences.

ARCHITECTURE LIBRARY — This specialized library houses a collection with emphasis on the topics of design, architectural history and theory, graphic communication, and building technology including over 10,000 cataloged volumes, 120 periodicals and over 24,000 slides for architecture faculty use. This library is open to the University community and general public on a reference basis.

UNIVERSITY OF ARIZONA MUSEUM OF ART — The University of Arizona is exceptionally fortunate to possess several outstanding art collections. Housed in the Museum are the masterpieces of the Samuel H. Kress Collection, which include the surviving panels of the Retablo of Ciudad Rodrigo by Fernando Gallego, and one of the finest university collections of Renaissance 16th- and 17th-century art in the United States. Contemporary international painting and sculpture are well represented in the Edward Joseph Gallagher III Memorial Collection; in the Jacques Lipchitz sketches and models; and in the C. Leonard Pfeiffer Collection, which was the first collection donated to the University. Temporary exhibitions are presented throughout the year, and the Museum conducts a very active education outreach program. The Museum of Art is open to the public daily from 9 to 5, and on Sunday from 12 to 5. There is no admission fee.

JOSEPH GROSS GALLERY and ART DEPARTMENT PRINT COLLECTION — The Joseph Gross Gallery of the Department of Art, created by means of a generous gift to the University from Professor Joseph F. Gross in memory of his father, Mr. Joseph Gross, is a professional art gallery featuring exhibitions of works by artists throughout the United States and occasionally foreign countries. Occasionally, the work of graduate students and faculty members is exhibited as well. The gallery’s exhibitions include works of fiber, graphic design, painting, sculpture, photography, ceramic and metal crafts.

The Department of Art maintains and displays its own collection of original graphic prints, ranging from the 15th to the 20th century. It presents a cross-section of authentic prints throughout the history of this art form, including early engraving, etching, wood-cut and lithography. Important donations by Mr. and Mrs. H. Kelley Rollings and Mrs. Helen Murphey have given this collection a public importance which augments its original intent, that of a teaching collection for university art students.

The UNIVERSITY OF ARIZONA PRESS, founded in 1959 as a department of the University of Arizona, is a nonprofit publisher of regional and scholarly 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.

From its early days as a small regional publisher, the Press has broadened its list to include scholarly titles in anthropology and archaeology, space sciences, arid lands studies, biology, Latin American studies, Asian studies, American Indian studies, and other fields. Also on the UA Press list are trade books on the Southwest borderlands, including accounts by scholars and professional writers of the natural history, geography, history, folklore, and lifeways of the region. The UA Press does not publish children's books or volumes of original fiction or verse.

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.

Twenty-seven people are on the staff of the University of Arizona Press. In addition, sales representatives market UA Press books throughout the United States, Canada, Europe, and parts of Asia. The manufacture of books is by contract, and the UA Press has no
direct affiliation with the printing services of the University of Arizona. Also appearing under the Press imprint is the historical quarterly *Arizona and the West*, whose separate editorial and subscription office is in the UA Main Library.

The **WATER RESOURCES RESEARCH CENTER**, an interdisciplinary organization formed in response to the U.S. Congress's Water Resources Act of 1964, is primarily devoted to assistance to water-related research activities at the three state universities. In addition, the Center conducts certain special research investigations within its organization. This work includes the harvesting of additional water from arid and semi-arid watersheds; artificially recharging the groundwater aquifers; evaporation suppression; seepage control; urban hydrology; and operation and maintenance of the research facility on the Casa Grande Highway, and one undeveloped and three urbanized watersheds, all in or near Tucson. Lastly, the Center, together with the Office of Arid Lands Studies, manages a Water Information Center for disseminating the results of water-related research in the state.

**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.

The **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. The manuscript collections are especially rich, with letters, diaries, journals, business records and other documents, many of which are still partially or completely unpublished. One of its most valuable research resources is its file of over 2,000 bound volumes of Arizona newspapers beginning with the first issue of the first weekly in 1859. State and federal historical records are on microfilm, as are records from Spanish colonial archives. Membership is open to everyone.

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.

Though it is primarily a field research station for professional biologists, biology classes and graduate students are encouraged to conduct research at the station or to use it as a base for field operations; and a number of University faculty and students do so.

Station living facilities and equipment are excellent, and the laboratory is well equipped for many kinds of modern field and laboratory research in ecology and physiology. The station is an excellent 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.

FEES

The Board of Regents reserves the right to change all fees and charges without notice, if necessary.

LEGAL RESIDENTS OF ARIZONA:

<table>
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<tr>
<th>Expense</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Registration fee*</td>
<td>$990.00</td>
</tr>
<tr>
<td>Residence halls, minimum rate**</td>
<td>$614.00</td>
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<tr>
<td>Meals in university cafeteria</td>
<td>$1,600.00</td>
</tr>
<tr>
<td>Books and supplies</td>
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<tr>
<td><strong>Total minimum annual expense</strong></td>
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NONRESIDENTS OF ARIZONA:

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<tr>
<td>Nonresident tuition fee***</td>
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<tr>
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<td>Meals in university cafeteria</td>
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<td>Books and supplies</td>
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<tr>
<td><strong>Total minimum annual expense</strong></td>
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MISCELLANEOUS EXPENSES

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<tr>
<td>Music fee for private lessons, per semester* * *(1/2 hr. per week - $40, 1 hr. per week - $60). See General Catalog for details.</td>
<td>$10.00</td>
</tr>
<tr>
<td>Change-of-schedule fee</td>
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<tr>
<td>Foreign student language examination fee (any one examination)</td>
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</tr>
<tr>
<td>Application for degree candidacy fee</td>
<td>$10.00</td>
</tr>
<tr>
<td>Late application for degree candidacy fee (see Graduate Calendar for deadlines)</td>
<td>$2.00</td>
</tr>
</tbody>
</table>
Processing fee (thesis or dissertation) 10.00
Dissertation microfilm fee 25.00
Caps and gowns are purchased for $16.54 or $19.43,
depending upon degree.
Hoods are purchased for $13.65 or
$16.28, depending upon degree.
Transcript fee, after one free transcript
(Instantaneous service is $3.00) 1.00

* The registration fee for seven or more units includes services and facilities of student activities, Student Union, Health Service, Parking, Alumni Association and Artist Series. Students taking fewer than seven units pay $53.00 per unit per semester.
**Average residence hall rates are approximately $1,000 per student per year and are subject to increase for the 1985-86 and 1986-87 academic year.
***For seven through 11 units of course work, the nonresident tuition per semester is: $833.00 for 7 units; $952.00 for 8 units; $1,071.00 for 9 units; $1,190.50 for 10 units; $1,309.00 for 11 units. The nonresident tuition is waived for graduate assistants currently on appointment and for students taking fewer than seven units.
****Graduate assistants currently on appointment are exempt from music fees in the major field if the student is a music major.

HOUSING

SINGLE GRADUATE STUDENTS — One residence hall is reserved for graduate students. This hall is modern and fully air-conditioned. A request for Graduate Student Housing form is included in the admissions packet. Additional information may be obtained by writing to the Department of Residence Life.

MARRIED STUDENTS AND SINGLE-PARENT FAMILIES — The University has 420 apartments, located about six miles from the campus, available for qualified married students and single-parent families. Interested students should write directly to the Department of Residence Life; 3401 North Columbus Boulevard; Tucson, Arizona 85712 for additional information.

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 $210.00.

STUDENT COUNSELING AND SERVICES

A wide variety of counseling and personnel services is available to students, including the Student Counseling Service (for counseling on educational-vocational or life planning, and for personal adjustment problems); the Student Health Service (Infirmary); the Speech and Hearing Clinic; the University Placement Service (for help in finding temporary and permanent employment); the Disabled Students Services Program (individualized and group services); the Foreign Student Adviser; the American Indian Student Adviser; and the Veterans’ office. For full information concerning each of these the student should consult the Dean of Students Office or the General Catalog.
General Regulations

THE NATURE OF GRADUATE WORK — 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. 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. Admission is granted only after approval of the candidate's previous academic record by the Dean of the Graduate College and the head of the department in which the candidate proposes to do the greater portion of major academic work. 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. An additional number of undergraduate courses may be required when previous work has not approximated the general requirements for the corresponding bachelor's degree at the University of Arizona or the special requirements for the field in which the candidate proposes to specialize. With departmental approval, a limited number of deficiencies may be satisfied after admission to a graduate degree program but without graduate credit. Students whose preparation is such that they are temporarily unable to elect any work for graduate credit must register in the appropriate undergraduate college.

REGULAR GRADUATE STATUS — Students who meet the admission requirements outlined above may be admitted to Regular Graduate Status to undertake work leading to an advanced degree.

UNCLASSIFIED GRADUATE STATUS — University of Arizona graduates or qualified Arizona residents who are not admitted to graduate degree programs may apply for admission to Unclassified Graduate status for the purpose of undertaking work to suit their needs. Except for submission of Graduate Record Examination scores and approval of the heads of departments in which a prospective student plans to study, such applicants must meet the admission requirements outlined above. Graduate students who complete an advanced degree and, subsequently, register for additional course work without being admitted to another advanced degree program will be placed in Unclassified Graduate status. Unclassified Graduate students may earn graduate credit as their qualifications and performance warrant; but no student may later apply toward an advanced degree more than six units earned as an Unclassified Graduate student.

ADMISSION OF FOREIGN STUDENTS — Nonimmigrants should request graduate application forms from the Graduate Student Admissions Office and departmental requirements and materials from the major department.

All foreign student applications, with the required credentials, should reach the Graduate Student Admissions Office-F before May 15 for the fall term; September 15 for the spring term; and April 1 for the summer sessions. It is frequently very difficult to evaluate properly a foreign student's preparation in terms of University requirements for advanced degree programs. Many graduates of foreign institutions are therefore admitted routinely as International Special Students with the
understanding that they may be required to undertake certain work without graduate credit in order to make up deficiencies in preparation, and that no commitment can be made in any case regarding the time required to complete a course of study. The decision as to whether an International Special Student can qualify for graduate credit will be made after the student has established a satisfactory record of performance in graduate course work.

Foreign students must demonstrate proficiency in English as one of the conditions for admission. The University requires all foreign applicants whose native language is other than English and who have not completed at least two academic years of full-time study in the United States, English-speaking Canada, the United Kingdom, Australia, or New Zealand, unless that study has resulted in a bachelor's or higher degree, to take the Test of English as a Foreign Language (TOEFL). 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 foreign students whose native language is not English may also be required to take a locally administered English test and to enroll for any further English courses which may be recommended.

Foreign students on nonimmigrant visas must certify that they possess adequate financial 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-F, in advance, what the terms of support will be. If the University is to bill for tuition and fees, billing must be through an embassy or an agent in the United States. In addition, foreign 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 insurance plan only when their government or sponsoring agency has submitted accident and insurance plans acceptable to the University of Arizona. Additional information and costs of this coverage will be sent to those foreign 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. Completed application forms must arrive before supporting transcripts come or processing will be seriously delayed. An applicant from another institution should request that two sets of complete official transcripts of all undergraduate and graduate work done and degrees received be sent directly by the institution at which the work was done to the Dean of the Graduate College of the University of Arizona. Both the application and the transcripts should be on file at least three months prior to registration. 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.

GRADUATE RECORD EXAMINATIONS — To supplement other evidence of preparation for graduate work, the Graduate Council has authorized the use of the Graduate Record Examinations. These examinations will not replace other records of achievement as a basis for admission to the Graduate College, but they will offer additional evidence concerning the qualifications of students desiring to undertake graduate work.

A number of departments have specific requirements with regard to the Graduate Record Examinations, the Graduate Management Admissions Test, and other examinations. Departmental headnotes in the Graduate Catalog and academic departments should be consulted for further information.

It is strongly recommended that, in addition to providing transcripts of records of all previous academic work, each applicant for admission to the Graduate College take the Graduate Record Examinations and submit a transcript of the scores. Applications for the examinations, which are administered locally as well as in other centers, should be sent, together with the examination fee, to Graduate Record Examinations, Educational Testing Service; Box 1502; Berkeley, California 94701; or Box 955; Princeton, New Jersey 08541.
Application materials are available in the office of the Graduate College and from the Educational Testing Service.

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.

GRADUATE CREDIT FOR SENIORS AND UNCLASSIFIED (NOT GRADUATE) STUDENTS — A University of Arizona student of senior standing who 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 adviser. The Dean will not approve a petition unless the senior has a grade-point average of 3.0000 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.

An unclassified (not graduate) student at the University who holds the bachelor’s degree may petition for permission to take courses for graduate credit. The petition must be filed at registration time, must be recommended by the instructor of the course and the head of the department concerned, and must be approved by the Dean of the Graduate College.

GENERAL PREREQUISITES FOR MAJOR GRADUATE CREDIT — The undergraduate major, or its equivalent, in any field of study is prerequisite to major graduate work in that field. In some cases, a field of concentration in undergraduate work different from but suitably related to the graduate major may be acceptable. The minimum requirement in education is fifteen units, of which three may be in general psychology, anthropology, or sociology.

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

REGULAR GRADUATE CREDIT COURSES — Regular courses numbered at the 500, 600, 700, and 900 levels are intended for graduate students, while approved 400-level courses, indicated by a GC in the course listing, may be taken for graduate credit by graduate students and by undergraduates who have received prior, written permission of the Dean of the Graduate College. (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.

OTHER COURSES FOR GRADUATE CREDIT — In addition to the regularly scheduled campus offerings, the University also offers a variety of special courses. Such courses are designated by numbers of four digits. The first digit — 4, 5, or 6 — indicates the type of course instruction. The last three digits are the same as the number of the regular campus offering unless there is no such counterpart.

All courses given by television for credit are designated by four-digit numbers beginning with 5. As many as eighteen units of graduate credit may be applied to meeting the requirements for the master’s degree, except that this limit is reduced by the number of units of transfer work offered. No course in the 5000 series may be applied toward meeting the requirements for the doctoral degree. Correspondence courses are designated by four-digit numbers beginning with 4. No courses in the 4000 series may be used toward a graduate degree. Short courses are designated by a four-digit number beginning with 6. All graduate courses in the 6000 series may be applied toward the requirements of graduate degrees.
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. Furthermore, the application of transfer work toward meeting requirements for a master's degree will reduce the number of units of work in the 5000 series acceptable for the same program (see "Other Courses for Graduate Credit" above).

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 accepted or would be acceptable toward an advanced degree at the institution where the work was completed. Furthermore, transfer will be made of credit only; no account will be taken of the grades of transfer work in computing the student's grade point average. Such transfer, which must be arranged by the student through the Graduate Degree Check Office, may be initiated at any time but will not become effective until the student has completed satisfactorily at least twelve units of graduate work at the University of Arizona.

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

CORRESPONDENCE COURSES — Correspondence courses will not be accepted for graduate credit.

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 section on "Pass/Fail Option")  
P - Passing (see paragraph on "Special Grades" and section on "Pass-Fail")  
S - Superior (see paragraph on "Special Grades")  
I - Incomplete  
K - Course in progress  
W - Approved withdrawal  
O - Audit  
CR - Credit  
N - Administrative drop

EXAMINATIONS REQUIRED — 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.

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, 695, 696, 697, 791, 793, 794, 795, 796, 798, 900, 908, 909, 910, 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, 696, 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, C, D, E, K, and W. The only grades available for 908, 909, 910, 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 work attempted in residence at the University.

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 adviser 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 the grade point average.

SCHOLARSHIP REQUIREMENTS — A high level of performance is expected of students enrolled for graduate credit. 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 will be 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 the approved graduate study program set up by the major department. Students who do not meet condition (b) may take additional 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.

FULL-TIME STUDENT STATUS — Full-time status for graduate students is widely variable, depending upon assistantship and associateship duties and the constitution of the individual student's program. Students in doubt about their standing should check with the Graduate College.

MAXIMUM ENROLLMENT — The maximum enrollment allowed per semester for students registered in the Graduate College is sixteen units. Students are asked not to request permission to take more than this maximum.

SUPPLEMENTARY REGISTRATION — Each student 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 course work will be required; during any summer term one unit of course work will be required. The minimum course work registration requirement may be met by registering officially for any single course or combination of courses for which the total number of units meets or exceeds the specific minimum.

Each student completing requirements for an advanced degree must be registered during the semester or summer term during which requirements are completed, or the previous semester or term if requirements are completed during an intersession. Students who have previously enrolled for all the regular courses required for their degrees and who still must register should enroll for supplementary registration (course number 930). Supplementary registration may be used concurrently with other enrollments to meet the unit registration requirement.
THESIS AND DISSERTATION WORK IN ABSENTIA — Under conditions approved by the head of the major department, 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 officially by registering as an auditor, the units are included in the student's unit 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. All courses numbered at the 500, 600, 700, or 900 levels are graduate courses and carry graduate credit. Approved 400-level courses which are identified by GC in the catalog are also available for graduate credit to properly qualified students.

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.

EXPENSES — Tuition per unit of credit for the 1985-86 academic year is $53.00. There is no additional nonresident fee for out-of-state students. In addition to the per unit tuition fee, students are assessed a student fee of $20.00 per five-week term ($4.00 per week for those registering for short courses only). Since fees are subject to change, students should consult the current Summer Session Schedule of Classes for fees in effect for any given year.

GRADUATE APPOINTMENTS, SCHOLARSHIPS AND FINANCIAL AIDS

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. Assistantships and Associateships

Teaching and research assistantships are available in many University departments. Approximately 2,000 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 $2,430 to $3,840 for services not exceeding ten hours a week, or $4,860 to $7,700 for half-time assistantships. Except by permission of the Graduate College, a student may hold a graduate assistantship or associateship only in the department of the major subject.
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 maintain a University of Arizona graduate grade point average of 3.00 or better.

MINIMUM ENROLLMENT — 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.

MAXIMUM ENROLLMENT — 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.

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

B. 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.

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

Graduate Academic 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.

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.

C. Loans

Loan programs in which graduate students may participate include, but are not limited to, National Direct Student Loans (NDSL), 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.
**Graduate Degrees**

### MAJOR FIELDS FOR MASTER'S DEGREES

Major work leading to a master's degree is offered in each of the following fields:

<table>
<thead>
<tr>
<th>Accounting</th>
<th>Electrical Engineering</th>
<th>Music Education</th>
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<tbody>
<tr>
<td>Aerospace Engineering</td>
<td>Engineering Mechanics</td>
<td>Musicology</td>
</tr>
<tr>
<td>Agricultural Economics</td>
<td>English</td>
<td>Music Theory</td>
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<tr>
<td>Agricultural Education</td>
<td>English as a second</td>
<td>Nuclear Engineering</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Language</td>
<td>Nursing</td>
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<tr>
<td>Agronomy &amp; Plant Genetics</td>
<td>Entomology</td>
<td>Nutritional Sciences</td>
</tr>
<tr>
<td>American Indian Studies</td>
<td>Exercise &amp; Sport</td>
<td>Optical Sciences</td>
</tr>
<tr>
<td>Animal Physiology</td>
<td>Sciences</td>
<td>Oriental Studies</td>
</tr>
<tr>
<td>Animal Science</td>
<td>Family &amp; Consumer</td>
<td>Performance (Music)</td>
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<tr>
<td>Anthropology</td>
<td>Resources</td>
<td>Pharmacology</td>
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<tr>
<td>Applied Mathematics</td>
<td>Finance</td>
<td>Pharmacy</td>
</tr>
<tr>
<td>Architecture</td>
<td>Food Science</td>
<td>Philosophy</td>
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<tr>
<td>Art</td>
<td>Foundations of Education</td>
<td>Physics*</td>
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<tr>
<td>Art Education</td>
<td>French</td>
<td>Planetary Sciences</td>
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<tr>
<td>Art History</td>
<td>General Biology</td>
<td>Planning</td>
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<tr>
<td>Astronomy</td>
<td>Genetics</td>
<td>Plant Pathology</td>
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<tr>
<td>Atmospheric Sciences</td>
<td>Geology</td>
<td>Plant Protection</td>
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<tr>
<td>Bilingual/Bicultural</td>
<td>Geosciences</td>
<td>Political Science</td>
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<tr>
<td>Biochemistry</td>
<td>German</td>
<td>Poultry Science</td>
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<tr>
<td>Botany</td>
<td>Health Education</td>
<td>Psychology</td>
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<tr>
<td>Business Administration</td>
<td>Higher Education</td>
<td>Public Administration</td>
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<tr>
<td>Business Education</td>
<td>History</td>
<td>Range Management</td>
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<tr>
<td>Cellular &amp; Developmental Biology</td>
<td>Home Economics Education</td>
<td>Reading</td>
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<tr>
<td>Chemical Engineering</td>
<td>Hydrology</td>
<td>Rehabilitation</td>
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<tr>
<td>Chemistry</td>
<td>Industrial Engineering</td>
<td>Renewable Natural Resources Studies</td>
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<tr>
<td>Classics</td>
<td>Journalism</td>
<td>Romance Languages</td>
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<tr>
<td>Composition (Music)</td>
<td>Landscape Architecture</td>
<td>Russian</td>
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<tr>
<td>Computer Science</td>
<td>Linguistics</td>
<td>Sociology</td>
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<tr>
<td>Counseling &amp; Guidance</td>
<td>Management &amp; Policy</td>
<td>Soil &amp; Water Science</td>
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<tr>
<td>Creative Writing</td>
<td>Management Information</td>
<td>Special Education</td>
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<tr>
<td>Dairy Science</td>
<td>Systems</td>
<td>Speech &amp; Hearing</td>
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<tr>
<td>Dietetics</td>
<td>Marketing</td>
<td>Speech Communication</td>
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<tr>
<td>Distributive Education</td>
<td>Materials Science &amp; Engineering</td>
<td>Statistics</td>
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<tr>
<td>Drama</td>
<td>Mathematics</td>
<td>Systems Engineering</td>
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<tr>
<td>Ecology &amp; Evolutionary Biology</td>
<td>Mechanical Engineering</td>
<td>Toxicology</td>
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<tr>
<td>Economics</td>
<td>Microbiology</td>
<td>Water Resources</td>
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<tr>
<td>Educational Administration</td>
<td>Mineral Economics</td>
<td>Administration</td>
</tr>
<tr>
<td>Educational Media</td>
<td>Mining Engineering</td>
<td>Watershed Management</td>
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<tr>
<td>Educational Psychology</td>
<td>Molecular Biology</td>
<td>Wildlife &amp; Fisheries</td>
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<td>Science</td>
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*Applicants are not admitted directly to this degree program. The degree is awarded only in rare instances when individuals admitted to Ph.D. programs are forced to terminate early.*
MAJOR FIELDS FOR SPECIALIST DEGREES

Major work leading to a specialist degree is offered in each of the following fields:

- educational administration
- educational media
- educational psychology
- elementary education
- microbiology
- nursing
- reading
- secondary education
- special education

MAJOR FIELDS FOR DOCTORAL DEGREES

Major work and research leading to a doctoral degree are offered in the following fields. (Except as noted, the degree is the Doctor of Philosophy.)

aerospace engineering
agronomy & plant genetics
anatomy
animal physiology
anthropology
applied mathematics
arid lands resource sciences
astronomy
atmospheric sciences
biochemistry
botany
business administration
cellular & developmental biology
chemical engineering
chemistry
civil engineering
composition
  (music/A.Mus.D.)
computer science
conducting
  (music/A.Mus.D.)
counseling & guidance*
ecology & evolutionary biology
economics
educational administration*
educational psychology*
electrical engineering
elementary education*
engineering mechanics
English
English education
entomology
foundations of education*
French
general biology
geekines
geography
geological engineering
geosciences
higher education
history
horticulture
hydrology
linguistics
materials science & engineering
mathematics
mechanical engineering
microbiology
mineral economics
mining engineering
molecular biology
music education
  (A.Mus.D.)
music theory
nuclear engineering
nursing
nutritional sciences
optical sciences
Oriental studies
performance
  (music/A.Mus.D.)
pharmaceutical chemistry
pharmacology and toxicology
pharmacy
philosophy
physics
physiology
planetary sciences
plant pathology
political science
psychology
range management
reading*
rehabilitation*
renewable natural resources studies
secondary education*
sociology
soil & water science
Spanish
special education*
speech & hearing sciences
speech communication systems engineering
water resources
administration
watershed management
wildlife and fisheries
science

*Both Ph.D. and Ed.D. degrees are offered.
ADVANCED DEGREES OFFERED

Full descriptions of programs and requirements for each of the following degrees are found elsewhere in the Graduate Catalog.

Master of Accounting (M.Ac.)
Master of Agricultural Education (M.Ag.Ed.)
Master of Architecture (M.Arch.)
Master of Arts (M.A.)
Master of Business Administration (M.B.A.)
Master of Education (M.Ed.)
Master of Fine Arts (M.F.A.)
Master of Home Economics Education (M.H.E.Ed.)
Educational Specialist (Ed.S.)
Doctor of Education (Ed.D.)
Doctor of Musical Arts (A.Mus.D.)

Master of Landscape Architecture (M.L.Arch.)
Master of Library Science (M.L.S.)
Master of Music (M.M.)
Master of Public Administration (M.P.A.)
Master of Science (M.S.)
Master of Teaching (M.T.)
Nursing Specialist (N.S.)
Specialist in Microbiology (Sp.M.)
Doctor of Philosophy (Ph.D.)

A number of departments offer work leading to more than one degree, and a great many specializations are available within the degrees listed. Details regarding degree programs and specializations are given in the informative text preceding the listings of course offerings for each department. While no specific graduate degree is required for junior college teaching, the normal minimum preparation includes a master's degree. For information on certification see "Majors for Junior College Personnel" in the College of Education section, General Catalog.
Requirements for Master's Degrees

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 one 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, (c) approved thesis credit in absentia, and (d) a limited number of graduate-level television courses (5000 series). For restrictions on the applicability of transfer credit and television courses 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 (adviser) 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 DEGREE STUDY PROGRAM — See the Graduate Calendar for deadline dates by which the Master's Degree Study Program must be submitted to the Graduate College. This notice, approved by the major professor 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 at least one half of the required units be offered in graduate, university-credit courses in which regular grades (A, B, C) have been earned. Acceptance of this notice by the Dean of the Graduate College will constitute approval of advancement to candidacy for a master's degree.

THESIS — A thesis is required in many master's programs. The appropriate departmental statement in this catalog will indicate thesis requirements for each degree. Where a thesis forms part of the program, a limited number of units may be earned for its preparation. Two copies of the completed thesis, conforming to the requirements of the Graduate College and approved by the major department, and an abstract of 150 words or less shall be deposited with the Graduate College at least fifteen days before the date on which degrees are
awarded. A third copy of the thesis may be required by the major department at its option. A manual of instructions relating to the form 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.

**PUBLICATION OF THESIS** — Master's theses are published by University Microfilms, Ann Arbor, Michigan. 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 processing with the thesis and must be carefully prepared 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 later, 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.

**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) chosen by the major department. The result of the examination must be reported to the Graduate College within two weeks. 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 one semester. The second examination is final. The report of successful completion of all requirements must be made to the Graduate College at least 21 days before the date on which degrees are awarded.

**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 in departmental headnotes.

**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.

Submission of the results of the Graduate Management Admissions Test and an academic average of approximately 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; and upper-division accounting electives, 6 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 12-hour core: Acct. 510, 522, 531, and 581. There are also 12 hours of specified courses which must be completed in the program if not previously completed: Acct. 401, 422, 431, and 472. 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 Home Economics Education/Consumer 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 may 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 three 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 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 nonbusiness majors, as well as for business majors. Previous business courses are not required. Undergraduate courses in Finite Mathematics (Math 119) and Elements of Calculus (Math 123), or the equivalents, are prerequisites and
should be completed prior to entering the program. If the math deficiencies are not eliminated before beginning course work, students must enroll in M.I.S.400 (a fast-paced finite math and calculus course) during the first semester.

Admission to the program is for the fall semester only. The full-time M.B.A. program is scheduled to cover four academic semesters. A four-year part-time evening program is also available.

All application materials should be sent directly to the Office of Graduate Professional Programs in the College of Business and Public Administration. All applicants are required to submit scores for the Graduate Management Admissions Test (GMAT). (Entering students have had an average GMAT score above the 80th percentile and a four-year undergraduate grade-point average well over 3.0.) Applicants must also arrange for two letters of recommendation and two official copies of transcripts for each university and college attended. An educational/vocational resume and brief essays on several assigned topics are also required.

There are 39 units of comprehensive core courses and 18 units of specialization electives required for the degree. Elective courses must be approved in advance by the Program Director. A variety of specialization elective courses and seminars are available to allow students to develop a concentration in virtually any field of business and public administration. Full-time students completing the program in four academic semesters enroll in course work in the following sequence:

Third semester (Fall): M.A.P. 500 (3); Environmental Elective (3), Specialization Electives (9). Total units - 15.
Fourth semester (Spring): M.A.P. 571 (3); Specialization Electives (9). Total units - 12.

Students with prior academic training equivalent to required core course work (with the exception of M.A.P. 500 and M.A.P. 571) may, with approval, substitute a more advanced course in the same department.

MASTER OF EDUCATION

This degree 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/bicultural education, business education, counseling and guidance, distributive 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, French, general biology, geography, German, health education, history, journalism, mathematics, Oriental studies, physics, political science, Russian, Spanish, and speech communication. Students with any of these majors will have an adviser 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.

A minimum of 32 graduate units including at least 17 units which are pertinent to the major must be completed. At each registration the courses elected must be approved by the student's adviser. All graduate degree candidates must complete E.D.F.A. 603 or obtain an
official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. No thesis is required. If the major is within the College of Education, students are urged to elect supporting work in other departments which strengthens their preparation and serves their special interests. If the major is outside the College of Education, no fewer than twelve units in education are required. An appropriate graduate study program should be developed in consultation with an adviser at the beginning of the student’s graduate work. All candidates must pass, in their major fields, a final examination, which may be written, oral, or both. Students with majors outside the College of Education must also pass a final examination in education. Examinations are scheduled near the end of each regular semester and during each summer session. Students must register for the examination at least three weeks prior to the date on which it is scheduled. Students should check with the Office of Graduate Studies in Education regarding dates and registration procedures. The examination may be repeated after a lapse of one semester, but no student will be permitted a third attempt to pass the final examination. No student will be recommended for the award of an advanced degree unless a grade point average of 3.00 or better has been achieved (a) on all work taken for graduate credit and (b) on all work in the graduate study program.

MASTER OF FINE ARTS

The Departments of Art, Drama, and English offer programs leading to the Master of Fine Arts degree with majors in art, drama, 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 and ask 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 slides of their studio work (or in the case of the photography program applicants, original photographs) directly to the Department of Art. All other application materials, including transcripts, are to be sent to the Graduate College. No application will be considered until slides or photographs, transcripts, and application forms have been received. The requirements are the same as those for the degree of Master of Arts with the following exceptions. The unit requirement for this program is sixty units, of which twelve must be in history of art and 48 in studio art courses. 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 or poetry. 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 modern literature is given at the end of the student’s work. There is no foreign language requirement.

MAJOR IN DRAMA — The unit requirement for this program is sixty units. Concentrations are available in acting-directing or in design-technical production. Applicants for the acting-
REQUIREMENTS FOR MASTER'S DEGREES

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.

**Acting-Directing Option:** Program requirements are Dram. 430, 431 or 432, 475, 605, 606, 449, 451, 452, 455 or 456, 650, 655, six units of 497 and at least nine units of theatre history, dramatic theory, or criticism. In lieu of a thesis, each student must present a monograph on the performance of a major character including the creation of the character and a journal of rehearsal and performance, or present a monograph on the direction of a full-length play including the pre-production study, analysis of the play, and record of production.

**Design-Technical Production Option:** Emphases are available in scenic design, lighting design, costume design, costume production, and technical production. Degree requirements are nine units of theatre history and/or dramatic theory and criticism and at least forty units of graduate level design, technical production and/or theatre workshop courses. In lieu of a thesis, an original design or production project must be accomplished during the University Theatre season. This will be accompanied by a written document including renderings, photographs, working drawings, and other information describing the produced creative design. This document will not be considered to be a thesis but must be presented to the advisory committee upon completion of the design project and the final oral examination.

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**MASTER OF LANDSCAPE ARCHITECTURE**

This is a graduate professional degree program involving the investigation of new thoughts and applications which advance the art and science of landscape architecture. The program is designed to provide opportunities for individual research. Students with undergraduate preparation in design-related fields and others who have research interests in topics related to landscape architecture are encouraged to apply. Students with undergraduate preparation in other fields who plan to practice as professional landscape architects, however, should enroll in the Bachelor of Landscape Architecture program instead. For information concerning this degree see the General Catalog.

Applicants should send a two-page statement indicating their goals and their reasons for desiring graduate study in landscape architecture. They should also have three letters of recommendation sent. Both the statement and the letters should be addressed to the Graduate Admissions Committee, Program in Landscape Architecture, School of Renewable Natural Resources, University of Arizona.

The program requires completion of a minimum of thirty units of graduate credit. However, because the program is tailored to each student's goals and abilities, additional units may be required. Six to nine units may be earned for preparation of the required thesis. A more detailed description of this program is available from the Graduate Admissions Committee.

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**MASTER OF LIBRARY SCIENCE**

The Graduate Library School offers a program leading to the Master of Library Science degree. This degree qualifies graduates for professional positions in all fields of librarianship including academic, public, and special libraries. To be qualified for school libraries, specified education courses are required for certification. See also the headnotes under Library Science elsewhere in this catalog. The Graduate Library School is accredited by the American Library Association.

For admission consideration, the applicant must have completed a bachelor's degree program with a broad and well-balanced undergraduate curriculum and with a grade-point average of 3.00 or higher. Applicants must also submit scores not more than five years old on the Miller Analogies Test or the aptitude test of the Graduate Record Examination, a personal resume and statement of purpose, and two letters of recommendation to the
Graduate Library School. Previous library experience is strongly recommended, and a personal interview may be required. The interview may be held in Tucson or, by arrangement, at other locations. Applications and all supporting materials must be received by June 1 for fall admission, by December 1 for spring admission, and by May 1 for summer session admission.

The program requires completion of 38 graduate units including Li.S. 502, 503, 504, 505, 506, 510, 582, and 507 or 581. Students who have completed courses similar to these at other institutions may have these courses waived as requirements based upon successful completion of screening examinations.

Additional graduate courses must then be substituted to bring to total number of earned graduate units up to 38. A foreign language requirement must be met by either (a) four semesters of college-level foreign language with grades of C or better (or submission of satisfactory scores on the Graduate School Foreign Language Test), or (b) two semesters of one foreign language with grades of C or better and, in addition, one of the following four options: (1) two semesters of a second foreign language with grades of C or better, (2) competence in a computer programming language (COBOL, FORTRAN, etc.), (3) competence in statistics, or (4) competence in manual communication. A final examination is required. No thesis is required.

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 are admitted through a screening process that requires audition by personal interview or tape recording.

MAJOR IN PERFORMANCE

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major instrument or voice (Mus. 685)</td>
<td>8</td>
</tr>
<tr>
<td>Recital (Mus. 925)</td>
<td>4</td>
</tr>
<tr>
<td>Ensemble (Mus. 500, 501, or 605)</td>
<td>4</td>
</tr>
<tr>
<td>Music Theory</td>
<td>3</td>
</tr>
<tr>
<td>Music History or Music Education</td>
<td>6</td>
</tr>
<tr>
<td>Music Electives</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
</tr>
</tbody>
</table>

MAJOR IN COMPOSITION

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<tr>
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</thead>
<tbody>
<tr>
<td>Advanced Composition (Mus. 640)</td>
<td>12</td>
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<tr>
<td>Thesis (Mus. 910)</td>
<td>3</td>
</tr>
<tr>
<td>Major instrument or voice</td>
<td>4</td>
</tr>
<tr>
<td>Ensemble (Mus. 500 or 501)</td>
<td>2</td>
</tr>
<tr>
<td>Music Theory (Mus. 621a-621b or 623)</td>
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</tr>
<tr>
<td>Conducting (Mus. 570)</td>
<td>3</td>
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<tr>
<td>Electives</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
</tr>
</tbody>
</table>

A recital of original compositions is required of the student before applying for candidacy for the major in composition.
REQUIREMENTS FOR MASTER'S DEGREES

MAJOR IN MUSICOLGY

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music History</td>
<td>12</td>
</tr>
<tr>
<td>Thesis (Mus. 910)</td>
<td>3</td>
</tr>
<tr>
<td>Major instrument or voice</td>
<td>2</td>
</tr>
<tr>
<td>Ensemble (Mus. 500q)</td>
<td>2</td>
</tr>
<tr>
<td>Musicology</td>
<td>3</td>
</tr>
<tr>
<td>Introduction to Graduate Study (Mus. 600)</td>
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</tr>
<tr>
<td>Electives</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

A reading knowledge of French or German is required of the student before applying for candidacy for the major in musicology.

MAJOR IN MUSIC EDUCATION

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>Music Education</td>
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<tr>
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<td>2</td>
</tr>
<tr>
<td>Ensemble (Mus. 500 or 501)</td>
<td>2</td>
</tr>
<tr>
<td>Composition or Music Theory</td>
<td>3</td>
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<tr>
<td>Music History</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</table>

MAJOR IN MUSIC THEORY

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Music Theory</td>
<td>12</td>
</tr>
<tr>
<td>Thesis (Mus. 910)</td>
<td>3</td>
</tr>
<tr>
<td>Major instrument or voice</td>
<td>4</td>
</tr>
<tr>
<td>Ensemble (Mus. 500 or 501)</td>
<td>2</td>
</tr>
<tr>
<td>Music History</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Graduate students in musicology, music theory, and composition must establish minimum piano proficiency at the 110d level.

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 in corporate organizations dealing with the public sector. Graduates may expect to pursue management careers in a wide variety of settings within organizations at local, state, national and international levels.

In addition to a basic management and public administration foundation core, the program consists of a chosen area concentration plus a chosen management skills concentration. Area concentrations are regularly offered in public management, health services administration, long term care administration, and criminal justice administration. With prior approval of the director, students may pursue special area concentrations where interests and available supporting courses warrant.

Management skills concentrations are offered in accounting, finance, human resources management, management information systems, marketing, operations management and research methods.

The program may normally be completed in four academic semesters. It consists of 54 graduate units, including 33 units of public management foundations (governmental and financial accounting, management information systems, micro-economics, public finance, organizational theory and behavior, management communication, statistics, fiscal and budgetary administration, and program evaluation methods), 12 units in the chosen area concentration and 6 units in the chosen management skills concentration. In addition, a 3 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. For those with mathematics deficiency, M.I.S. 400 must be completed before or during the first semester of graduate study.

A typical course of full-time study is as follows:

First semester: Acct. 550; Econ. 500a, M.A.P. 552, 601; M.I.S. 400 (if necessary for mathematics deficiency).
Second semester: Acct. 551 or 572; Econ. 534; M.A.P. 502; M.I.S. 501.
Third semester: M.A.P. 500, 605; Area and skills concentration courses (9 units).
Fourth semester: M.A.P. 610, Area and skills concentration courses (9 units).

The Internship is usually completed in the summer between the first and the second years, though exceptions may be approved.

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. Admission requirements are the same as for other master's degrees offered through the Departments of Elementary Education and of Secondary Education except that the minimum requirement of 15 units of undergraduate credit in education may be reduced or waived for those engaged in positions where evidence of other appropriate course work or experience is presented.

Graduate study programs must consist of a minimum of 32 graduate units of which at least eighteen must relate directly to the teaching field or professional experience of the candidate. All course work for the degree may be completed off campus in approved university-credit, graduate-level courses. Extension credit will not be accepted from other institutions. As many as nine units of approved residence credit earned at other accredited institutions may be transferred to apply toward requirements for the degree, and as many as six additional units of approved university credit may be transferred from Arizona State University and Northern Arizona University.

Candidates for this degree shall develop a program of study with the advice and approval of an adviser and of the major department. This program of study shall be submitted prior to undertaking more than six units of applicable graduate credit at the University of Arizona or a total of fifteen units of applicable graduate credit (University of Arizona and transfer work combined). A thesis is not part of the requirements for this degree.

All candidates must pass a comprehensive written final examination, to be given on campus or at one of the University Program Centers. In addition, each candidate shall submit an evaluation of his or her own teaching or supervisory work, demonstrating increased competence in professional practice. Candidates must register for the final examination at least three weeks prior to the examination date. No student may so register unless he or she has completed or is currently completing 32 units of applicable graduate work and has or can obtain a grade point average of 3.00 (B) or better.
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. The programs leading to the degree are in greater scope, depth, and thoroughness of preparation than are represented by most master's degrees, but they are distinct from the doctorate in a number of respects. Emphasis is placed upon the preparation of the practitioner.

ADMISSION — Completion of fifteen semester hours in professional education is a prerequisite to admission to the program. Admission is based upon: (1) an application for admission to the Graduate College, (2) transcripts of all previous college work, (3) a completed Personal Data Blank, (4) scores on the Graduate Record Examinations as listed in the departmental headnotes, and (5) three letters of recommendation. Test scores and scholastic record will meet those standards required for admission to a doctoral program in the department concerned. Applicants should submit complete applications by March 1 for fall admission and by November 1 for spring admission.

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 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 adviser. 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 the Office of Graduate Studies in Education, and (3) to be available to the student for advice as needed.

PROGRAM OF STUDY — A program of study, recommended by the department head and approved by the Office of Graduate Studies in Education, shall be submitted promptly for the approval of the Graduate Council following successful completion of the qualifying examination. It is to 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. All graduate degree candidates must complete E.D.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research.

The two-year program for the degree may be administered as a unit (including the master’s degree) or it may be organized following the completion of the master’s program. In either case it shall consist of not fewer than 60 units of graduate work, including relevant course work from the master’s program. No fewer than 24 of the last thirty units shall be taken on campus at the University of Arizona.

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.

NURSING SPECIALIST

The Nursing Specialist degree provides education and experience in a particular subspecialty area of nursing beyond the level normally attained in a master’s program. Emphasis is placed upon the preparation of the practitioner. The program is an intensive one, requiring full-time attention to courses and associated seminars and practicums. Please contact the College of Nursing for current offerings.

ADMISSION — Applicants are required to submit: (1) a current license to practice as a registered nurse in one of the fifty states, (2) references attesting to professional competence, (3) evidence of satisfactory completion of a first course in statistics, (4) scores on the Aptitude Test of the Graduate Record Examination, (5) a statement indicating academic and professional goals as well as research interests, and (6) evidence of completion of a bachelor's or master’s degree program substantially equivalent to the same degree program at the University of Arizona. Students without the master’s degree will enter the combined Master of Science and Nursing Specialist program, but confirmation of admission to the Nursing Specialist program will be made only after a minimum of one semester of clinical work in the master’s program at this institution.

PROGRAM — The program provides education and experience in a particular subspecialty area of nursing beyond the level normally attained in a master’s degree program. The program is intensive and requires full-time attention to courses and associated seminars and practicums. Programs of study are individually planned in consultation with an adviser after consideration of previous academic work and experience, personal interests, and professional objectives. Two options are available: (1) An applicant with a bachelor’s degree in nursing may enroll for the combined M.S. and N.S. degree programs by declaring the intent to prepare in a subspecialty area. A minimum of 60 units must be completed, including 36 from the courses required for the clinical concentration leading to the M.S. degree plus an additional 24 units of course work. This option generally requires two semesters beyond the time required for completion of the master’s degree (see the headnotes under Nursing elsewhere in this catalog). The thesis will be directed toward some aspect of nursing care in the selected subspecialty area. (2) An applicant who has completed the master’s degree in nursing at an institution accredited by the National League for Nursing may receive the Nursing Specialist degree by completing a minimum of 28 units.

QUALIFYING EXAMINATION — To demonstrate acceptability to undertake work leading to candidacy for the specialist degree, individuals who are taking the entire program at the University of Arizona (including the master’s) will be evaluated as to their suitability on the basis of the first semester’s work toward the Master of Science degree. Applicants with a
master's degree in nursing from another school will be asked to demonstrate acceptability during their first term in residence, either through an examination or careful evaluation of their performance in course work.

Prior graduate credit completed in a master's program elsewhere and essentially equivalent to the master's program offered at the University of Arizona may be accepted in transfer if it is relevant to the specialist degree program at this institution and if the student has kept abreast of current developments in the field. Graduate credit to be applicable with full value toward the specialist 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.

A research paper and a final comprehensive examination are required for the Nursing Specialist degree.

SPECIALIST IN MICROBIOLOGY

This program is a two-calendar-year curriculum designed for students who wish to prepare for careers as supervisors in clinical or public-health laboratories, teachers in allied health programs of community colleges or other institutions, or service in environmental health departments of various governmental agencies.

Admission requirements include: (1) a bachelor's degree in microbiology or a related field; (2) sixteen units of undergraduate-level microbiology, including courses equivalent to University of Arizona courses in microbiology, general mycology, introductory immunology, and pathogenic microbiology; (3) chemistry (general chemistry and qualitative analysis—one year, organic chemistry—one year lecture and laboratory, quantitative analysis—one semester; a beginning course in biochemistry is highly recommended); (4) mathematics (a minimum of eight semester hours, including college-level algebra and trigonometry); (5) physics (one year for which trigonometry is prerequisite); (6) biology (one year of general biology or equivalent courses in botany and zoology); (7) registration with either the National Registry of Microbiologists as a microbiologist or the A.S.C.P. as a medical technologist.

Applicants must also submit scores of the Aptitude Test of the Graduate Record Examination and three recommendations on forms available from the Department. Students lacking some of the units or required courses (see one through six above) will be expected to make up the deficiencies either by registering for the courses without receiving graduate credit or by examination.

To receive the Specialist in Microbiology degree, a student must demonstrate a breadth of knowledge in the field by exhibiting proficiency in several areas. These areas include: microbiology, biochemistry, computer programming, management, and education. Each student, with the assistance and direction of an advisory committee appointed by the department head, will plan an appropriate program of study with a minimum of sixty units of required and elective course work. These requirements may be satisfied by (1) obtaining a grade of B or better in an appropriate course at the University of Arizona, (2) executing successfully a comprehensive examination in an area at the 75-percent level, or (3) demonstrating an adequate (B level) performance in a course of similar content as either an undergraduate or graduate student at another institution. In the last case, such course work may be evaluated by examination or accepted at face value at the discretion of the department.

This is a terminal degree program, and no thesis is submitted. A research paper and a final comprehensive oral examination, however, are required.

Students interested in pursuing a program leading to the Doctor of Philosophy degree with a major in microbiology should follow the curriculum outline under the Master of Science degree program in microbiology described elsewhere in this catalog.
Requirements for Doctor’s Degrees

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 academic 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 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 his or her graduate work. (See next paragraph for the only exceptions to this general requirement.)

Graduate assistants or graduate associates can discharge the minimum residence requirement in two semesters during each of which they register for nine units or more of work for graduate credit, provided their full time is devoted to their graduate work and assistantship or associateship responsibilities. Students on appointment to any teaching or research position at the University can discharge the minimum residence requirements 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 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 dissertation committee and the head of the department, dissertation work may be done in absentia.

All requirements for the degree, including work done for the master’s degree (if applicable), must be met within 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 Council. 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 should be submitted for approval by the Graduate Council on a form provided by the Graduate College prior to the completion of half of the nondissertation units proposed.

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, no later than six months after successful completion of the first of these portions, an oral portion which shall be conducted before a committee of the faculty appointed by the Graduate College upon consultation with the major and minor departments. 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 only visitors permitted at this 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 be recommended to the Graduate Council for acceptance as a candidate for the doctorate. These requirements must be met no later than three months prior to the date of the final oral examination.

DISSERTATION — No later than three weeks prior to the proposed date of the final examination, the completed Final Oral Examination Request Form is filed with the Graduate College. A copy of the penultimate draft of the dissertation is then delivered by the candidate to the Graduate College representative appointed to the examining committee. Following the examination, the candidate submits to the Graduate College for review a final copy of the completed dissertation (approved and accepted by the major department and all members of the examining committee), the approval pages and special abstract, along with the Notice of Completion of Final Examination and Dissertation Requirements. After making any required corrections, the candidate submits two complete and signed copies of the dissertation to the Graduate College for submission 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. 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 of $25 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 methods later, 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.

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 Graduate College in consultation with the major and minor departments.

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 requirements for the degree of Doctor of Philosophy, see above.)

Preliminary admission to the program is recommended by the academic department and the Office of Graduate Studies in Education to the Graduate College. Before an application is acted upon, the applicant must: (1) file an application for admission to the Graduate College, (2) forward transcripts of all previous college work to the Graduate College, (3) file a completed Personal Data Blank with the Office of Graduate Studies in Education, and (4) submit scores on the Graduate Record Examinations, as listed in the appropriate departmental headnotes, to the Office of Graduate Studies in Education. Applicants are urged to submit complete applications by March 1 for fall admission and by November 1 for spring admission.

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 student is registered for at least nine units of graduate course work or research will be counted as meeting the minimum 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.)

Graduate assistants or graduate associates (half time or less) can discharge the residence requirement in two semesters during each of which they register for nine units or more of work for graduate credit, provided their full time is devoted to their graduate work and assistantship or associateship responsibilities. Students on appointment to any teaching or research position at the University can discharge the residence requirement by four semesters during each of which they complete 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 is understood to require the equivalent of at least two semesters of full-time work. Registration for eighteen units of dissertation credit (920) is required during the conduct of the dissertation, with a maximum of nine units during any regular semester. If the dissertation is to be written in absentia, prior arrangements must be made through the
head of the appropriate academic department, and must have the favorable recommenda-
tion of the Dean of the College of Education.

Requirements for the Doctor of Education degree must be completed within a period
of six calendar years after the qualifying examination.

MAJOR AND MINOR SUBJECTS — The student will major in counseling and guidance,
educational administration, educational psychology, elementary education, foundations of
education, higher education, reading, rehabilitation, secondary education, or special educa-
tion. The student may minor either inside or outside of the College of Education as approved
by the adviser and department heads concerned, by the Office of Graduate Studies in
Education, and by the Graduate Council. At least 46 units of work, exclusive of dissertation,
must be in education.

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.

TEACHING EXPERIENCE — Candidates for the degree of Doctor of Education are required
to furnish evidence of at least three years of successful teaching or administrative experi-
ence in schools. Exceptions to this requirement are made occasionally for students spe-
cializing in some areas within counseling and guidance, rehabilitation, and school
psychology.

ADVISORY COMMITTEE — After successfully passing the Qualifying Examination, the stu-
dent may request that the head of the major department appoint three members to an
advisory committee, and that the head of the minor department appoint two members to the
committee. The name of the chairperson and the names of other committee members
should be reported to the Office of Graduate Studies in Education. The duties of this
committee are to review the proposed dissertation problem, to evaluate the student's pro-
posed study program, to be available to the student when guidance is necessary and to
serve as members of the preliminary and final examination committees.

PROGRAM OF STUDY — A proposed program of study recommended by the department or
departments concerned should be submitted for approval by the Graduate Council on a
form provided by the Graduate College prior to the completion of half of the nondissertation
units proposed. All graduate degree candidates must complete E.D.F.A. 603 or obtain an
official waiver from the Educational Foundations and Administration Department to demon-
strate equivalent preparation in research. Doctoral candidates must also complete Ed.P.
640.

FOREIGN LANGUAGE REQUIREMENT — A reading knowledge of a foreign language will be
required when such knowledge is necessary for the successful completion of the
dissertation.

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,
not later than six months after successful completion of the first of these portions, an oral
portion which shall be conducted before a committee of the faculty appointed by the Gradu-
ate College upon consultation with the major and minor departments. The preliminary exam-
ination 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 recommenda-
tion of the examining committee, endorsed by the major department and approved by the
Graduate Council. The only visitors permitted at this examination are regular University faculty members. There are four examination periods, one in each semester of course work.

**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. These requirements must be met not later than three months prior to the final oral examination.

**DISSERTATION** — No later than three weeks prior to the proposed date of the final examination, the completed Final Oral Examination Request Form is filed with the Graduate College. A copy of the penultimate draft of the dissertation is then delivered by the candidate to the Graduate College representative appointed to the examining committee. Following the examination, the candidate submits to the Graduate College for review a final copy of the completed dissertation (approved and accepted by the major department and all members of the examining committee), the approval pages and special abstract, along with the Notice of Completion of Final Examination and Dissertation Requirements. After making any required corrections, the candidate submits two completed and signed copies of the dissertation to the Graduate College for submission 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 of $25 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 later, 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 Education at the University of Arizona.

**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 to any general questioning related to his field of study which may develop therefrom. 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 Graduate College in consultation with the major and minor departments.

**DOCTOR OF MUSICAL ARTS**

The School of Music of the Graduate College accepts prospective candidates for the degree of Doctor of Musical Arts. The degree is granted in the fields of music education, 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 will be found under "Music" in this catalog.
Preliminary admission to the program is recommended by the Committee on Graduate Study in Music. Before this committee will act on an application, the applicant must: (1) file an application for admission to the Graduate College, (2) forward transcripts of all previous college work to the Dean of the Graduate College, (3) file a completed Application to Graduate Work in Music with the School of Music Graduate Committee, (4) submit a tape recording of performance 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 two regular semesters 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 9 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.)

Graduate assistants or graduate associates (half-time or less) can discharge the minimum residence requirement in two semesters during each of which they register for 9 units or more of work for graduate credit, provided their full time is devoted to their graduate work and assistantship or associateship responsibilities. 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 6 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 18 units of dissertation (920) or recital (925) credit is required during the conduct of the dissertation or preparation for the recitals. A maximum of nine units of dissertation credit and six units of recital credit may be elected in any regular semester. If the dissertation is to be written in absentia, prior arrangements must be made through the head of the appropriate academic department, and must have the favorable recommendation of the School of Music.

All requirements for the Doctor of Musical Arts degree must be completed within a period of six calendar years from the date the qualifying examination is passed.

MAJOR AND MINOR SUBJECTS — The student will major in conducting, composition, music education, 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 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, these 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 the School of Music 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 department or departments concerned should be submitted for approval by the Graduate Council on a form provided by the Graduate College prior to the completion of half of the nondissertation units proposed.
FOREIGN LANGUAGE REQUIREMENT — A reading knowledge of a foreign language will be required when, in the judgment of the student's advisory committee, such knowledge is necessary for the successful completion of the dissertation.

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, no later than six months after successful completion of the first of these portions, 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 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 only visitors permitted at this examination are regular University faculty members.

ADVANCEMENT TO CANDIDACY — After passing the written and oral portions of 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 degree of Doctor of Musical Arts. These requirements must be met no later than three months prior to the final oral examination.

DISSERTATION — No later than three weeks prior to the proposed date of the final examination, the completed Final Oral Examination Request Form is filed with the Graduate College. A copy of the penultimate draft of the dissertation is then delivered by the candidate to the Graduate College representative appointed to the examining committee. Following the examination, the candidate submits to the Graduate College for review a final copy of the completed dissertation (approved and accepted by the major department and all members of the examining committee), the approval pages and special abstract, along with the Notice of Completion of Final Examination and Dissertation Requirements. After making any required corrections, the candidate submits two complete and signed copies of the dissertation to the Library. A processing fee must be paid to the University Cashier. The School of Music, at its option, may require an additional copy of the dissertation for its files. 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 of $25 is charged to cover this expense. Upon certification by the student's major professor, members of the committee for the final examination, and the Dean of the Graduate College, one 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 microfilmed, and the negative is inspected and put in vault storage. The manuscript is cataloged and this information is sent to the Library of Congress for printing and distribution of cards to depository catalogs and libraries. The abstract is included in Microfilm Abstracts, which is distributed to leading libraries here 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 later, and successful candidates are urged to submit dissertation material for publication through appropriate media. 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 Musical Arts at the University of Arizona.

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 to 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.

OTHER EXAMINATIONS — Before being admitted to the final oral 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, that are thought proper by 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.

The student majoring in composition will, in lieu of a dissertation, write a large-scale composition scored for full or chamber orchestra (with or without soloists), for symphonic band or for voice (or chorus) and orchestra. An abstract including the formal, stylistic, and technical elements of the composition must accompany the work.

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 MUSIC EDUCATION — Applicants for the Doctor of Musical Arts degree 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 either in the public schools or at the college level.

The candidate will write in the field of specialization a dissertation which will be a scholarly contribution to the field of musical and educational knowledge.

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 (this recital must include a major work assigned by the instructor of applied music and prepared independently by the student within a period of 30 days), (2) an ensemble performance with an instrumental or vocal chamber group, or an appearance with orchestra, (3) a lecture-recital, and (4) a final public recital (must follow a successful preliminary examination).

The four recitals must include representative literature from all major periods. Each recital will be evaluated independently by the School of Music Graduate Committee and the area faculty concerned. 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 for the lecture-recital. This document, based on some aspect of performance or performance practices, must show evidence of the candidate's ability to select and organize data pertinent to the study. Ideally, it should be an original contribution to the field of knowledge in the candidate's chosen subject area.

SPECIFIC REQUIREMENTS FOR THE MAJOR IN CONDUCTING — Concentration in either choral or instrumental music (may include opera) is required, but candidates must demonstrate competency in both areas. Approval to elect this major will be based on a personal audition with appropriate faculty and evidence of successful conducting experience prior to application. The Graduate Study Program will include private instruction in conducting (785-Cg) to the extent of twelve units. 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 recital in the secondary conducting area, (3) a lecture-recital, and (4) a final public recital.
CURRICULAR CHANGE

Course listings in the following departmental sections are subject to change. Curriculum changes approved during the first year of the catalog's biennium 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 Curriculum Office, Administration Building, Room 116. Because the catalog designation of semesters of offering is subject to change, students should consult the Schedule of Classes for curricular planning of a particular term. Schedules for fall and spring classes are available from the Information Desk, Administration Building, 2nd Floor, in April and October, respectively. The Summer Schedule of Classes is available in January from the Office of the Summer Session, Administration Building, Room 116. For a complete statement of the student's responsibility in maintaining acquaintance with current University requirements, see the copyright page of this catalog.

EXPLANATORY NOTES

CLASSIFICATION OF COURSES (THE NUMBERING SYSTEM) — The number by which a course is designated indicates the level of the course.

Courses numbered:

100-299 inclusive: Lower-division courses primarily for freshmen and sophomores.
300-499 inclusive: Upper-division courses primarily for juniors and seniors.
300-399: Advanced-intermediate-level courses. Not available for graduate credit.
400-499: Advanced-level courses. Acceptable for graduate credit with the prior approval of the Graduate College, except 400-level individual studies courses (491, 493, 494 or 499, with or without subscripts).
500-599 inclusive: Graduate courses. Open to exceptionally well-qualified seniors with the prior written approval of the course instructor and the Graduate College.
600-699 inclusive: Graduate courses. Not open to undergraduate students.
700-799 inclusive: Graduate courses limited to doctoral students.
800-899 inclusive: Courses limited to students working for degrees offered by the College of Medicine or the College of Pharmacy. Not available for credit toward other degrees.

SEMESTER COURSES (SINGLE NUMBERS) — A course designated by a single number (as Economics 248) is one semester in length.

YEAR COURSES (DOUBLE NUMBERS) — A course designated by a double number (as Political Science 233a-233b) 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. Credit is awarded for the first half of the course except in a few instances when credit in the first half is contingent upon completion of the second half.

PREREQUISITES — A student registering for a course must meet the prerequisites or otherwise satisfy the instructor of his or her preparation to take the course. Prerequisites can be waived only at the discretion of the instructor or department involved.

ADDITIONAL COURSES — In addition to the courses listed in this catalog, courses offered for no credit through the Division of Continuing Education are listed in the catalog for that division.

CANCELLATION OF COURSES — The University reserves the right to cancel courses not elected by an adequate number of students.
FOREIGN LANGUAGE COURSES — In addition to courses taught in the language departments, sections of other University courses may be taught in a foreign language from time to time.

KEY TO SYMBOLS

The standard course description includes a variety of symbols indicative of essential information. The following is a standard course description with the individual symbols explained in the order in which they appear in that description.

SAMPLE COURSE LISTING

406. Social Structure in Modern Societies (3) [Rpt.] GC I 1986-87 GRD Critical review of modern theory and research on social structure and social organization in modern societies. 2R, 3L. P, six units of soc. or CR. (Identical with Hist. 406) Smith

406. — 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./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 six units of credit. It is the student's responsibility to ensure that course content is not duplicated.
GC — Graduate credit available. (Applies to 400-level courses only.)
I — Semester offered. I indicates fall semester; II, spring; S, summer.
1986-87 — Year in which course is offered. If no year designation is given, the course is offered each year.
GRD — GRD and CDT indicate that the course is available by examination. GRD indicates that the course is available by examination for a grade and credit, and CDT indicates that the course is available by examination for credit only. These options are not available for graduate credit.
Critical review...societies. — Course description.
2R, 3L — Class structure. R, L, and S indicate "recitation," "laboratory," and "studio." 2R, 3L indicates two hours of recitation and three hours of laboratory per week (based upon fifteen weeks). For courses consisting of lecture and recitation periods only, the number of class hours per week is the same as the unit value and is not specified in the course description.
P — Prerequisites.
CR — Concurrent registration.
(Identical with Hist. 406) — Other departments which give credit for the same course. If no course description appears, please consult the crosslisted department.
Smith — Professor in charge.

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

Symbols in other University Catalogs

Prefix Definition
4 Course offered by correspondence — no university or graduate credit.
5 Course offered by television — limited applicability toward advanced degree.
6 Course shorter in duration than normal semester or term — full university credit.

UNIVERSITY-WIDE "HOUSE-NUMBERED" COURSES

495, 595, 695, 795. Colloquium (Credit varies) The exchange of scholarly information and/or secondary research, usually in a small group setting. The exchange of ideas may involve written as well as oral communication. Research projects need not be required of course registrants.
GRADES AVAILABLE: A, B, C, D, E, I, S/P, W.*
496. Proseminar and 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.

*GRADERS AVAILABLE: A, B, C, D, E, I, S/P, W.*

497, 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.

*GRADERS AVAILABLE: A, B, C, D, E, I, W.*

Special or regular grades may be used as departmental policy dictates; however, in any given instance, all registrants must be graded by the same system.

Individual Studies

*Individual-studies courses are those with numbers ending in 91, 93, 94, 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.*

Supplementary Registration: Graduate students who have completed the course requirements of their programs and will be taking examinations or completing courses or projects initiated at an earlier date should register for supplementary registration. Students completing requirements for advanced degrees must be registered during the semester or summer term in which requirements are completed, or during the previous semester or term if requirements are completed during an intersession. Students who have previously enrolled for all the regular courses required for their degrees may register for supplementary registration (course number 930, one to nine units). All graduate students using University facilities or faculty time must register for 930 if not registered for anything else.

591, 691, 791. Preceptorship (Credit varies.) Specialized, advanced 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 study, laboratory work and patient study.

*GRADERS AVAILABLE: S/P, C, D, E, I, W.*

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

*GRADERS AVAILABLE: S/P, C, D, E, I, W.*

5931. Legislative Internship. (9) 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 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.

*GRADERS 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.

*GRADERS 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.

*GRADERS AVAILABLE: S/P, C, D, E, I, W.*

900. Research (Credit varies) Individual research by graduate students, not related to a thesis or dissertation the student will write for an advanced degree.

*GRADERS AVAILABLE: S/P, C, D, E, K, W.*

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

*GRADERS 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.

*GRADERS 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.

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. Graduate Recitals (1 to 9) For graduate 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.

**Credit received for this course is in addition to the units required for the advanced degree.

ACCOUNTING

Professors Russell M. Barefield, Head, William B. Barrett, Dan S. Dhalwal, William L. Felix, Jr., Dee L. Kleespie, Edward S. Lynn, Lyle H. McIlff, Louis A. Myers, Jr. (Emeritus)

Associate Professors Jack O. Foltz, Michael D. Shields

Assistant Professors Marcia S. Niles, William K. Salatka, Charles W. Swenson, William S. Waller, S. Mark Young

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, Master of Public Administration, and Doctor of Philosophy (major in business administration) 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.

401. Advanced Accounting I (3) GC II Theory and methodology involved in the preparation of consolidated financial statements and in accounting for partnerships. P, 300b or CR.

402. Financial Accounting Standards (3) GC II In-depth coverage of selected authoritative pronouncements and other special topics in financial accounting. P, 300b.

405. Foundations of Accounting and Auditing Theory (3) GC II Theoretical frameworks and analytical tools appropriate to the development and implementation of accounting and auditing theories. P, 310, M.A.P. 275.

410. Advanced Cost Accounting (3) GC II Theoretical issues of process and standard costing, performance measurement, differential cost analysis, and other selected topics. P, 310, 405.


422. Advanced Federal Taxation (3) GC I Introduction to advanced topics: taxation of corporations and stockholders' transactions in stocks; taxation of partnerships and fiduciaries; gift and estate taxation. P, 320, 401.

431. Principles of Auditing (3) GC I II The opinion formulation process of the professional auditor; the auditor's reports, professional standards, internal and operational auditing. P, 300b; 405 or M.A.P. 375.

461. Accounting Information Systems (3) GC II The analysis, design and implementation of information systems, with special emphasis on accounting applications. P, M.I.S. 121; 310 or 551. (Identical with M.I.S. 461)

472. Fund Accounting (3) GC II Budgetary and financial accounting, control, and reporting for governments and other not-for-profit organizations. P, 210, 272, or 550.

510. Principles of Profit Planning and Control (3) I The design and use of accounting information for managerial planning and control purposes. P, 310 or 551.

522. Tax Planning and Practice (3) I Selected topics of a tax-planning and tax-practice nature; extensive individual reading and research. P, 422.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Description</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>523</td>
<td>Estate Planning and Taxation (3) II</td>
<td>Advanced topics on gift and estate taxation; emphasis on the planning and structuring of financial activities to minimize the impact of income and wealth-transfer taxes.</td>
<td>P, 422, M.A.P. 426 or CR.</td>
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<tr>
<td>526</td>
<td>Corporate Taxation (3) II</td>
<td>Advanced topics in the taxation of corporations and of stockholders' transactions in corporate shares.</td>
<td>P, 401, 422.</td>
</tr>
<tr>
<td>527</td>
<td>Tax Aspects of Real Estate Transactions (3) II</td>
<td>Gains and losses on sales and exchanges of property for tax purposes; capital and ordinary gains and losses, realization, transfer by gift or at death, use in trade or business, installment sales, and depreciation recapture provisions.</td>
<td>P, CR 320.</td>
</tr>
<tr>
<td>531</td>
<td>Responsibilities of the Public Accountant (3) II</td>
<td>A professional course for those who expect to pursue public accounting as a career.</td>
<td>P, 431.</td>
</tr>
<tr>
<td>550</td>
<td>Financial Accounting Analysis (3) II</td>
<td>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.</td>
<td>Open only to students admitted to BPA graduate programs.</td>
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<tr>
<td>551</td>
<td>Managerial Use of Accounting Data (3) II</td>
<td>Case studies and text readings focused on utilization of accounting data in determining the possible results of alternative executive decision. Advanced degree credit available for nonmajors only.</td>
<td>Open only to students admitted to BPA graduate programs. P, 550, Econ. 500a or CR, M.A.P. 552 or CR.</td>
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<tr>
<td>553a-553b</td>
<td>Financial Accounting (3-3) S</td>
<td>Theory and methodology of net income determination; accounting for assets, liabilities, and owners' equity. Credit allowed for this course or 300a-300b, but not for both.</td>
<td>P, 210 or 551.</td>
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<tr>
<td>556</td>
<td>Tax Factors in Business Decisions (3) II</td>
<td>Introduction to the federal taxation of income for all types of taxpayers and to the taxation of transfers of wealth, with emphasis on the effect of taxes on business decisions. Open only to students admitted to BPA graduate degree programs. Not open to accounting majors. Credit allowed for this course or 320, but not for both.</td>
<td>P, 210 or 551.</td>
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<tr>
<td>581</td>
<td>Financial Accounting Theory (3) II</td>
<td>Topics in accounting theory and alternative accounting practices.</td>
<td>P, 300b or 553b.</td>
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<tr>
<td>596</td>
<td>Seminar</td>
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<tr>
<td>a.</td>
<td>Computers in Auditing (3) I II (Identical with M.I.S. 596a )</td>
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<tr>
<td>610</td>
<td>Contemporary Managerial Accounting Thought (3) II</td>
<td>Special topics in accounting theory and research. Of special interest to doctoral students.</td>
<td>P, 510.</td>
</tr>
<tr>
<td>682</td>
<td>Advanced Financial Accounting Theory (3) II</td>
<td>Issues in accounting theory with emphasis on the selection of accounting techniques.</td>
<td>P, 300b or 553b.</td>
</tr>
<tr>
<td>685</td>
<td>Contemporary Financial Accounting Thought (3) II</td>
<td>Special topics in accounting theory and research. Of special interest to doctoral students.</td>
<td>P, 682.</td>
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<td>696</td>
<td>Seminar</td>
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<tr>
<td>a.</td>
<td>Auditing (1 to 3) I II</td>
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<td>b.</td>
<td>Managerial Accounting (1 to 3) I II</td>
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<td>c.</td>
<td>Taxation (1 to 3) I II</td>
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<td>d.</td>
<td>Theory (1 to 3) I II</td>
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<td>e.</td>
<td>Behavioral (1 to 3) I II</td>
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AEROSPACE AND MECHANICAL ENGINEERING

Professors Chuan F. Chen Head, Roger A. Anderson (Emeritus), Francis H. Champagne, Harvey D. Christensen (Emeritus), Hermann F. Fasel, Arland G. Foster (Emeritus), Hussein A. Kamel, Dimitri B. Kececioglu, Robert B. Kinney, Donald M. McEligot, Edwin K. Parks, Henry C. Perkins, Jr., Russell E. Petersen, Willard L. Rogers (Emeritus), Lawrence B. Scott, Jr., William R. Sears (Emeritus), Quentin R. Thomson (Emeritus), Thomas L. Vincent, Paul H. Wirsching, A. Ralph Yappel (Emeritus)

Associate Professors Gregory R. Baker, Thomas F. Balsa, Edward B. Haugen (Emeritus), Parviz Nikravesh, Kumar N. R. Ramohalli, Robert B. Roemer, Bruce R. Simon

Assistant Professors Kee-Ying Fung, Ari Glezer, Juan C. Heinrich, Edward J. Kerschen, Seth H. Lichter, Arne J. Pearlstein, Robert A. Petersen

Associate Department Head Karl M. Pattison
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. Applicants who seek financial aid in the form of fellowships, assistantships and scholarships must submit scores of the Graduate Record Examination.

Majors

AEROSPACE ENGINEERING — Master of Science and Doctor of Philosophy degree programs prepare students for advanced work in aeronautics and astronautics. Several specializations are available, as listed under Mechanical Engineering below.

MECHANICAL ENGINEERING — Master of Science and Doctor of Philosophy degree programs prepare students for advanced work in many fields, including aerodynamics; flight mechanics and propulsion; biomedical engineering; energy systems engineering; engineering design and materials selection; fluid mechanics and heat transfer; interactive graphics and structural analysis; automatic control and optimization; reliability engineering and probabilistic design; solar energy; solid mechanics and structural dynamics; space systems engineering.

Degrees

MASTER OF SCIENCE — All students are required to complete 31 units of graduate work, including 24 at the 500 level and 1 unit of 696. A student may elect to present a Master's thesis (up to six units) or a Master's report (up to three units). All students are required to complete 532a-532b. (Students in the reliability engineering option may take 413a-413b as a substitute.) Normally, no more than three units of independent study or sponsored-projects courses may be taken for degree credit. All students are expected to attend the weekly graduate seminar. A final oral examination is required.

DOCTOR OF PHILOSOPHY — Students should take the Qualifying Examination during their first semester in residence. After completing all or nearly all the required course work and satisfying the foreign language requirement, the Preliminary Examination may be scheduled. Written examination on the major subject is given after the student has passed the written examination on the minor subject. Minor subjects may be chosen from other engineering, physical sciences, or mathematics departments. All students are expected to attend the weekly Aerospace and Mechanical Engineering Seminars.


406. Engineering Quality Control (3) GC I (Identical with S.I.E. 406)

408. Reliability Engineering (3) GC I Time-to-failure, failure-rate, and reliability determination for early, useful and wear-out lives; equipment reliability prediction; spare parts provisioning; reliability growth; reliability allocation. P, Math. 223, S.I.E. 320. (Identical with S.I.E. 408)
413a-413b. Reliability and Quality Analysis (3-3) GC 413a: Probability theory and statistical models in reliability, life testing, and design; descriptive and mathematical statistics, basic graphical and analytical data analysis techniques. 413b: Monte Carlo methods in reliability analysis, polynomial curve fitting and linear models, Bayes estimation, decision analysis in engineering design, stochastic processes in design. P, Math. 223.

417. Clinical Engineering (3) GC II (Identical with E.C.E. 417)

418. Physiology for Engineers (4) GC I (Identical with Psio. 418)

419. Physiology Laboratory (2) GC I (Identical with Psio. 419)


430. Mechanical Vibrations (3) GC I Free and forced vibrations of simple mechanical systems; effects of damping; introduction to multidegree of freedom systems. P, 232, Math. 254.


436. Finite Element Methods of Structural Analysis (3) GC I II Matrix algebra, computers, theory of elasticity, work and strain energy, energy theorems, the finite element, the assembled structure, programming aspects of the problem, general purpose programs, application to aerospace structures. P, 409a.


442. Heat Transfer (3) GC I II Study of conduction, convection and radiation heat transfer, with applications to engineering problems. P, 331a, 340a.

450R. Unit Operations in Metal Processing (3) GC I (Identical with M.S.E. 450R)

450L. Metal Processing Laboratory (1) GC I (Identical with M.S.E. 450L)

453. Air Conditioning Engineering (3) GC I Analysis and design of systems and components for control of temperature, humidity, air cleanliness and acoustics; applications to residential and commercial buildings. P, 340b, CR 331a. (Identical with N.E.E. 453)


456. Introduction to Turbo-Machines (3) [Rpt./1] GC I Theory of energy transfer in turbo-machine components; application to pumps, turbines, and compressors. P, 331b, 340b.

458. Wind Energy Conversion Systems (3) GC I Aerodynamic theory of vertical and horizontal axis propellers and windmills; optimal design of blades and electrical components; lab. and field measurements of operating systems. 3R, 1L. Field trips. P, 331a, E.C.E. 208.

460. Aerodynamics (3) GC I Basic equations and their approximation; potential flow theory; fundamentals of airfoil and wing theory; axisymmetric flows; application to aerodynamics of wings and bodies. P, 361, 432.

461. Gasdynamics (3) GC II Thermodynamics review; equations for one-dimensional flow; wave propagation and acoustics; isentropic flow; shock waves; simple two-dimensional flows; friction and heat addition. P, 331a, 340a.

463. Dynamics of Space Flight (3) GC I Spacecraft dynamics; orbital and attitude maneuvers, lunar and interplanetary transfer, re-entry. P, 232.

466. Stability and Control of Aerospace Vehicles (3) GC I Static and dynamic stability of rigid and nonrigid vehicles; automatic control of aircraft, missiles and space craft. P, 361.
467. Solar Energy Engineering (3) GC I (Identical with N.E.E. 467)

469. Energy Engineering Laboratory (3) GC I II (Identical with N.E.E. 469)

485. Biomechanical Engineering (3) GC II One subject covered yearly from: Biomechanical-solid mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation/exercise, hyperthermia, instrumentation). P, 310, 331b, 340b, CR 409a.

503. Modeling and System Identification In Dynamic Engineering Systems (3) I 1985-86 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, 310, CR 405.


505. Modern Control Theory (3) II 1986-87 Controllability and stability for linear and nonlinear systems, observer design, methods of optimal control and game theory applied to control system design. P, 405. (Identical with E.C.E. 505)

506. Advanced Quality Control and Reliability (3) II (Identical with S.I.E. 506)

507. Engineering Design Optimization (3) II Theory and practice of optimal design as an element of the engineering design process. Relationship to creativity, modeling, analysis, computation, and decision-making. Mechanical and structural system applications. P, 310, 409a.

508. Advanced Reliability Engineering (3) II Extension of 408; Complex systems reliability; maintainability engineering; reliability and availability of maintained systems; operational readiness; system effectiveness; maintainability demonstration. P, 408, S.I.E. 420. (Identical with S.I.E. 508)

510. Airplane and Helicopter Design (3) I Helicopter and airplane design and analysis; optimization of takeoff, climb, specific range, endurance; energy methods. P, 466.

512. Advanced Probabilistic Design (3) II Continuation of 423; advanced methods for mechanical and structural reliability analysis, system reliability analysis, random loading models, applications to fatigue, fracture, buckling, creep, etc. P, 423.

518. Reliability Testing (3) II Mean-time-between-failure and reliability confidence limits; sequential testing; sampling; accelerated, sudden-death, and suspended-items, non-parametric, and Bayesian testing. P, 408, S.I.E. 420. (Identical with S.I.E. 518)

520a-520b. Fundamentals of Fluid Mechanics (3-3) 520a: Fundamental equations of motions; surface tension; kinematics of vorticity; integral solutions; irrotational flows; simple viscous flows. P, 331b, CR 532a. 520b: Small-disturbance inviscid theory; low Reynolds number flow; vorticity dynamics; boundary layers. P, CR 532b.


532a-532b. Engineering Analysis (3-3) 532a: Mathematical models; operational techniques; functions of a complex variable; Fourier analysis. P, Math. 254. 532b: Linear analysis; ordinary and partial differential equations; methods of solution.


538. Finite Element Analysis In Nonlinear Solid Mechanics (3) I Finite element methods, including material nonlinearity (elastic, plastic, viscoelastic); geometric nonlinearity (finite deformations), numerical solution methods, and nonlinear programs. P, 436.
539. Advanced Structural Mechanics (3) II Advanced problems in structural analysis using the finite element method; analysis and optimization of complex systems; nonlinear and composite structures and material systems; application to other disciplines. P, 436. (Identical with E.M. 539)

540. Advanced Thermodynamics (3) I Reversible and irreversible macroscopic thermodynamics; selected engineering applications. P, 331a, 340a.

542. Convective Transport Phenomena (3) I Convective energy, mass and momentum transfer; internal and external flow; exact, approximate and numerical solutions; application to current problems. P. 442, CR 532a, computer programming ability.


545. Combustion Generated Air Pollution (3) II Pollutant formation in combustion processes and methods of control; diffusion models for atmospheric dispersion, including plume rise calculations. P, 331a, 340a. (Identical with Ch.E. 545)

546. Nature of Turbulent Shear Flow (3) II 1986-87 Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances. P, 520a-520b, 532b.

553. Aerodynamics of Propulsion (3) I 1985-86 Interior ballistics of rocket motors; ramjets, turbojets, turbofans; detonation wave theory; combustion chamber instability analysis; nozzle design. P, 461.

556. Combustion Gasdynamics (3) II 1985-86 Aerothermochemistry; fluid mechanics, thermodynamics, chemistry of propulsion and air pollution; reaction kinetics, combustion stability, detonation; singular perturbations in deflagration. P, 532a, 461.

557. Applied Combustion (3) II 1986-87 (Identical with Ch.E. 557).

560. Fluid Mechanics of Viscous Flows (3) I Behavior of viscous fluids over a range of Reynolds numbers; Navier-Stokes equations; boundary layer equations; slow flow; compressible boundary layers. P, 520b.


567. Advanced Solar Engineering (3) II (Identical with N.E.E. 567)

585. Advanced Biomechanics (3) II 1986-87 Fluid mechanics of the circulatory system; application of mechanics to soft and hard tissues, such as blood, blood vessels, muscle, skin, bone, tissue structure, properties and rheology; peristalsis and urodynamics. (Identical with Ch.E. 585)


615. Hydrodynamic Stability (3) I Introduction to linear stability theory in fluid mechanics; the Orr-Sommerfeld equation, behavior of eigen solutions, stability limits, extensions to problems in two component systems. P. 520a-520b, 532a-532b.

621. Advanced Computational Aerodynamics (3) I Governing equations for aerodynamic applications; iterative techniques for solving partial differential equations; grid generation and multi-grid techniques; applications to compressible viscous flows. P. 421, 520b, 532b.

695. Colloquium a. Research Conference (1) I II

696. Seminar g. Graduate Seminar (1) I II
The department offers a program leading to the Master of Science degree with a major in agricultural economics. A broad spectrum of agricultural economics subject matter is presented by the department, while special emphasis is given to the economics of natural resources. In cooperation with the Department of Economics, work is also offered leading to the Doctor of Philosophy degree with a major in economics, emphasis in agricultural or natural resource economics.

Students in the Master of Science degree program are required to complete a thesis or a technical paper. The option selected will be determined by the major professor in consultation with the graduate advisory committee and subject to approval of the department head. 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 technical paper option must complete 33 semester units including three units of 900 in which the technical paper is prepared.

**Courses**

403. Marketing and Price Analysis (3) GC II Market functions, costs, price forecasting, and regulation in the movement of agricultural products. Advanced degree credit available for nonmajors only. P, 439, Econ. 300. Monke

404. Production Economic Analysis (3) GC I Application of production economics principles and analytical techniques to the solution of agricultural economics problems. Advanced degree credit available for nonmajors only. P, Math. 117e, Econ. 300. Wade

412. Agricultural Economic Development in Latin America (3) GC II Review and analysis of economic growth and development in Latin America with special emphasis on the agricultural sector. P, Econ. 201a-201b. (Identical with Econ. 412 and Anth. 412) Fox

414. Rural Area Development (3) GC I Identification of current U.S. nonmetropolitan problems, economic principles useful in analyzing these problems, and possible program alternatives for rural area development. P, Econ. 201b or Geog. 305. (Identical with Geog. 414) Barkley

440. Forest Resource Economics (3) GC II (Identical with Ws.M. 440)

442. Transformation of Agarian Societies in the Middle East (3) GC II (Identical with Or.S. 442).

450. Agricultural Finance (3) GC I Applying business principles to problems confronting farm-ranch and incorporated agribusiness firms in the acquisition, allocation, control and transfer of capital resources. P, 215, or Econ. 300 and three units of acct. Wilson

464. Agricultural Policy (3) GC II Economic analysis of the policy issues and proposals impacting on agriculture and rural America, with emphasis on the historical and continuing role of government in price and income policies. Advanced degree credit available for nonmajors only. Hillman

470. Economics of Outdoor Recreation (3) GC II (Identical with N.R.R. 470)

471. Problems in Regional Development (3) GC I II (Identical with Geog. 471)

476. Natural Resource Economics (3) GC II Economic principles useful in analyzing natural resource problems and policies in the Southwest and nationwide. P, Econ. 201a-201b (Identical with Econ. 476, W.R.A. 476, and Ws.M. 476) Saliba

477. Economics of Water and Land Resources (3) GC I Economic analysis of policy issues in rural and urban water use and development. Economic analysis of multiple uses of public lands. P, 217 or 476 or Econ. 201a. (Identical with R.N.R. 477). Martin

480. Forest Policy and Administration (3) GC II (Identical with Ws.M. 480)

500. Research Methodology in Agricultural Economics (3) II Study of the research process in agricultural economics as an efficient means for acquiring reliable knowledge for problem solutions. Martin

504. Production Economics (3) I Theory of the firm and industry; single and multiple products; risk and uncertainty. (Identical with Econ. 504) Barkley/Wilson

512. International Agricultural Economic Development (3) II The role of agriculture in economic growth and development, including economic policies related to agriculture, and to world trade in agricultural commodities. (Identical with Econ. 512) Fox/Monke
513. **Agricultural Price and Marketing Analysis (3)** II Market organization, efficiency, and functions in a dynamic economy. (Identical with Econ. 513)

514. **Cost-Benefit Analysis (3)** II 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 and M.A.P. 514).

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)

539. **Statistical Methods (2)** I II (Identical with Agri. 539)


**AGRICULTURAL EDUCATION**

Professors Floyd G. McCormick, Head, Gordon J. Graham, Clinton O. Jacobs, Kenneth S. Olson

Associate Professor Phillip R. Zurbrick

Assistant Professor David E. Cox

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 work shall be in business administration, education, psychology, sociology or in other approved disciplines appropriate to teaching, extension, and 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.

448. **Extension Program Planning and Evaluation (3)** GC II (Identical with H.E.E. 448)

497. **Workshop**
   a. **Curriculum Development (1 to 3)** [ Rpt./3] GC I II
   b. **Occupational Experience Program (1 to 3)** [ Rpt./3] GC I II
   c. **Youth Leadership Development (1 to 3)** [ Rpt./3] GC I II
   d. **Continuing Education in Agriculture (1 to 3)** [ Rpt./3] GC I II
   e. **Program Planning and Evaluation (1 to 3)** [ Rpt./3] GC I II
   i. * Extension Communications (1 to 2) [ Rpt./2] GC (Identical with H.E.E. 497i)
   r. * Public Relations in Extension (1 to 20) [ Rpt./2] GC (Identical with H.E.E. 497r)

509. **Concepts of Vocational Education (2)** II Vocational education's role in fulfilling school and societal needs. Its effect on economic and social problems plus consideration of appropriate delivery systems and articulation.

538. **Philosophy and Principles of Extension Education (3)** I Social and economic significance of extension education in domestic and international situations. P, twelve units of ag. or f.c.r. (Identical with H.E.E. 538)

539. **Extension Education Methods (3)** II Acquisition of competencies in the development and application of non-formal education methods used by change agents to diffuse practical information. P, six units of a.ed. or education. (Identical with H.E.E. 539)
597. Workshop
   c. Extension Credibility and Accountability (1 to 2) [Rpt.1/2] (Identical with H.E.E. 597c)
   d. Extension Supervision and Administration (1 to 3) [Rpt.1/2] (Identical with H.E.E. 597d)
   g. Microcomputers-Extension (1 to 2) [Rpt.1/2] (Identical with H.E.E. 597g)
   t. Principles of Extension Training (1 to 3) I (Identical with H.E.E. 597t)
   u. Evaluation in Extension Education (1 to 3) I (Identical with H.E.E. 597u)
   v. Volunteer Staff Development in Extension (3) I (Identical with H.E.E. 597v, which is home)
   x. Administration of Extension Programs (1 to 3) I (Identical with H.E.E. 597x)

*Offered only through the Cooperative Extension Service Winter School.


615. Investigations and Studies in Agricultural Education (3) I Study and analysis of research literature, methods, techniques and procedures for conducting investigations; selecting a problem and developing plans for a study. P, nine units of a.ed. or education. Zurbrick

621. Program Planning (3) II Developing programs in agricultural teaching and extension; situation analysis, objectives, policies, content, procedures, and evaluative criteria. P, six units of a.ed. McCormick

AGRICULTURAL ENGINEERING
(See Soils, Water and Engineering)

AGRICULTURE

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 Landscape Architecture (M.L.Arch.), and Doctor of Philosophy (Ph.D.) degrees as indicated in the following list of departments and majors:

Agricultural Economics
   agricultural economics ............................................. M.S.

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

Animal Physiology (Committee)
   animal physiology ................................................ M.S./Ph.D.

Animal Sciences
   animal science ..................................................... M.S.
   dairy science ...................................................... M.S.
   poultry science ................................................... M.S.

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

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 Protection (Committee)
   plant protection .................................................. M.S.

Plant Sciences
   agronomy and plant genetics ..................................... M.S./Ph.D.
   horticulture ...................................................... M.S./Ph.D.
Renewable Natural Resources

- landscape architecture .................................................. M.L.Arch.
- range management .......................................................... M.S./Ph.D.
- renewable natural resources studies ................................. M.S./Ph.D.
- watershed management .................................................... M.S./Ph.D.
- wildlife and fisheries science ........................................... M.S./Ph.D.

Soils, Water, and Engineering

- agricultural engineering .................................................. M.S.
- soil and water science ................................................... M.S./Ph.D.

Veterinary Science

No graduate majors except in cooperation with certain other departments.

In special cases, an undergraduate field of concentration different from but related to the intended graduate major may be admissible.

Students with a special interest in genetics are referred to Genetics elsewhere in this catalog. For further information concerning any of the programs listed above, see the appropriate departmental headnotes and also see Requirements for Graduate Degrees elsewhere in this catalog.

The Agricultural Experiment Station offers the graduate student in agriculture an opportunity to participate in current research programs. The student may be assigned to a staff member of the Agricultural Experiment Station, under whose direction the research necessary to the writing of an acceptable thesis or dissertation is conducted. Residence credit may be earned for certain graduate courses offered at University facilities away from the Tucson campus.

General Courses in Agriculture

450. Alternative Futures in Energy and Environment (3) I GC Energy and environment status and future alternatives; interaction of food-fiber production and natural resource use, with emphasis on student discussion of diverse views. Caldwell

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) McDaniel/Caldwell/Ffolliott

539. Statistical Methods (2) I II Concepts and methods of inferential statistics, including probability distributions, estimation and testing hypotheses for common statistical problems. 10-week course. P, Math. 117e. (Identical with A.Ec. 539) Kuehl

A student should also take a third related unit, taught during the last five weeks of the semester and selected from among the following options:

- 539a. Analysis of Variance (1) I II P, 539.
- 539r. Regression Analysis (1) I II P, 539.
- 539s. Sample Surveys (1) II P, 539.

540. Design and Analysis of Experiments (3) II Design principles for complete and incomplete block designs, analysis of factorial experiments, split plot designs, analysis of covariance, analysis of series of experiments, orthogonal polynomials and multiple regression. P, 539a. Kuehl

609. Scientific Communication and Research Funding Methods (1) II 1985-86 Techniques and limitations of written, oral, and visual scientific communication; procedures and policies for research funding sources.

AGRONOMY AND PLANT GENETICS

(See Plant Sciences)
AMERICAN INDIAN STUDIES

Committee on American Indian Studies

Professors Robert K. Thomas, Director, James W. Clarke (Political Science), Vine Deloria, Jr. (Political Science), Jane H. Hill (Anthropology), N. Scott Momaday (English), James Officer (Anthropology), Susan W. Steele (Linguistics)

Associate Professors Barbara Babcock (English), Courtney Cleland (Sociology), Lawrence C. Evers (English), J. Jefferson Reid (Anthropology)

Assistant Professors Thomas M. Holm (Political Science), Earl W. Jernigan (Anthropology), Alice Paul (Elementary Education), Leslie Silko (English)

The Committee on American Indian Studies offers a Master of Arts degree with a major in American Indian studies that is designed to prepare students to teach at the college and university level and to work in community development and social programs.

Applicants must submit scores on the Graduate Record Examination, two letters of recommendation, and the personal and academic data called for on the American Indian Studies application form. Applicants are also invited to submit vitas, published articles or other materials relevant to admission.

MASTER OF ARTS (major in American Indian studies)—30 units, plus a six-unit thesis. The course work consists of 15 units of core courses, including 484a-484b, 502a-502b, and three units to be determined by the Committee. In addition, the student must complete 15 units in a field of concentration chosen from art, language, anthropology, literature, education, business or any other related area approved by the Committee. The student should work closely with three faculty advisers to develop a challenging individual program. In addition to the thesis, a final master's examination is required.

The Department of Political Science offers a Master of Arts degree with a major in political science with an emphasis on Indian policy that is designed to prepare students to work in tribal and private organizational work, to teach at the college and university level, and to work in a variety of public agencies in the area of civil rights and social programs. A concentration in American Indian studies provides students with a thorough background in the political history of the American Indian and the federal government and provides the tools and analytical skills necessary to understand the past and present situation of the American Indian, thus preparing the student for policy-making, tribal planning or other government positions. For information concerning this concentration, also see the Department of Political Science.

404. Sociology of the Southwest (3) GC I (Identical with Soc. 404)
415a-415b. Southwestern Indian Arts (3-3) GC (Identical with Anth. 415a-415b)
416. Contemporary Indian America (3) GC II 1965-86 (Identical with Anth. 416)
423. Peoples of Mexico (3) GC II (Identical with Anth. 423)
437. Issues in Indian Education (3) GC II (Identical with Ed.F.A. 437)
445a-445b. Structure of an American Indian Language (3-3) [Rpt./2] GC (Identical with Ling. 445a-445b)
449a-449b. Folklore (3-3) GC (Identical with Engl. 449a-449b)
461. Race and Ethnic Relations (3) GC I II (Identical with Soc. 461)
482. Hopi Language in Culture (3) GC II (Identical with Anth. 482)
484a-484b. Development of Federal Indian Policy (3-3) GC (Identical with Pol. 484a-484b)
487. Race and Public Policy (3) GC I (Identical with Pol. 487)
502a-502b. Dynamics of Indian Societies (3-3) Philosophies, institutions and characteristics of tribal life in North America. 502a: American Indian lifestyles prior to European contact. 502b: Impact of European immigration on tribal groups of North America. (Identical with Anth. 502a-502b)
596. Seminar
h. American Indian Law and Policy (3) [Rpt./2] 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)
The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in anatomy.

The undergraduate major need not be in the biological or chemical sciences, but the applicant must have completed courses in mathematics through calculus and analytical geometry; inorganic and organic chemistry; a year of general physics; and at least sixteen units in the biological sciences. It is advisable that the applicant present at least one course in comparative anatomy, genetics, or general physiology and a year of general zoology or biology. A limited number of deficiencies may be satisfied after admission and, if appropriate, graduate credit may be allowed. Applicants must submit scores on the aptitude test and one advanced test (biology preferred) of the Graduate Record Examination and four letters of recommendation from former science instructors familiar with their academic ability and personal character.

**Degrees**

**MASTER OF SCIENCE** — This degree is offered only in rare instances when individuals qualified to study for the doctorate are forced to terminate early. A final oral examination, a thesis based upon original research, and reading proficiency in one foreign language are required.

**DOCTOR OF PHILOSOPHY** — The degree program includes course work in gross anatomy, microscopic anatomy, and neuroanatomy. If acceptable courses have already been completed in one or more of these subjects, the student will be allowed to audit the corresponding course and assist in the laboratory. Acceptable minor subjects are anthropology, physiology, biochemistry, pharmacology, microbiology, or the biological sciences. At least three one-semester courses must be completed in the minor field.

Doctoral students majoring in other disciplines may, with the approval of an anatomy minor adviser, select anatomy as a minor field. The minor program will consist of at least sixteen units in anatomy.

456. **Developmental Biology** (4) GC I (Identical with M.C.B. 456)

457. **Experiments in Developmental Biology** (4) GC II (Identical with M.C.B. 457)

467R. **Endocrinology** (3) GC II Neural and endocrine integration in the regulation of mammalian physiological functions. P, M.C.B. 103. (Identical with M.C.B. 467R)

467L. **Endocrinology Laboratory** (1) GC II Techniques in endocrinology. P, CR 467R (Identical with M.C.B. 467L)

495. **Colloquium**

a. Introduction to the Neurosciences I (2) GC (Identical with Med. 495a, which is home)

550. **Topics in Pigment Cell Biology** (2) I Selected topics on the development function and control of normal and abnormal pigment cells in various pigmentary phenomena. (Identical with M.C.B. 550)

555. **Cancer Biology** (3) II 1986-87 (Identical with Micr. 555)

558. **Advanced Subjects in Endocrinology** (2) [ Rpt. ] I Selected topics in vertebrate and invertebrate endocrinology. P, 467R. (Identical with M.C.B. 558)

601. **Human Gross Anatomy** (8) I Comprehensive survey of the development and gross structure of the human body. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; Ecol. 101b; consult department before enrolling.
602. Microscopic Anatomy (5) I Essentials of microscopic human anatomy. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; Ecol. 101b; consult department before enrolling.

603. Microscopic Structure (1 to 3) 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 to 6) [Rpt.] II Study in depth of the gross human anatomy of selected areas or systems. P, 601, 602.

605. Neurosciences (6) II Essentials of mammalian neural development, structure and function. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; Ecol. 101b; M.C.B. 410a-410b. Consult department before enrolling. (Identical with Psio. 605)


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

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

696. Seminar
   b. Biological, Structural and Functional Interactions (1) [Rpt./4] II Open to majors only. P, Chem. 103b, 104b, 243b, 245b, Phys. 102b, Ecol. 101b.

801. Human Gross Anatomy (8) I No grade is given until the full seven units are completed.

802. Microscopic Anatomy (5)

805. Seminar

896. Seminar
   a. Embryology (1 to 6) II

ANIMAL PHYSIOLOGY

Committee on Animal Physiology (Graduate)

Professors Fred B. Roby, Chairperson, Robert B. Chiasson, Mac E. Hadley, Dewey E. Monty, Jr., Raymond E. Reed, Gerald H. Stott (Emeritus), Charles M. Tipton

Associate Professors Ronald E. Allen, Ronald W. Hilwig

Assistant Professors Roger M. Enoka, William A. Schurg, Mark E. Wise

The interdisciplinary Committee on Animal Physiology offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in animal physiology. It is recommended that applicants have a fundamental knowledge of zoology (including anatomy, physiology, and genetics), chemistry, mathematics, and physics. It is also recommended that applicants submit scores on the Graduate Record Examination.

A thesis is required for the Master of Science degree. Doctoral minors may be in animal sciences, veterinary science, biochemistry, nutrition, pharmacology, the biological sciences, chemistry, physical education, nursing, or other discipline approved by the committee.

Related Courses

Refer to the appropriate department for course descriptions. Courses which are applicable to the program are Agri. 539, 539a, 539n, 539r, 539s, 540; 413, 414, 415R, 415L, 430, 436, 601, 635; Chem. 460, 462a-462b, 480a-480b, 565a-565b; Ecol. 431, Ecol. 464aR-464bR, 468L, 468R, 489; Ex.S.S. 530, 550; Micr. 630; M.C.B. 410a-b, 412, 612; N.F.S. 406a-406b, 615, 617, 620; Ph.Sc. 430a-430b; Psio. 601, 605; Stat. 461; V.Sc. 400a-400b, 405, 423, 458, 459, 601.

596. Seminar
   a. Animal Physiology (1) [Rpt.] II
ANIMAL SCIENCES


Associate Professors Ronald E. Allen, R. Spencer Swingle

Assistant Professors Sue DeNise, William A. Schurg, Mark E. Wise

The department offers programs leading to the Master of Science degree with a major in animal science, dairy science, or poultry science. Concentrations are available in animal breeding and genetics, animal nutrition, animal physiology, and meat science and muscle biology.

Admission is generally dependent upon an undergraduate major in some field of animal agriculture and a basic background in biological, chemical, and physical sciences.

A thesis is required but may be waived in unusual circumstances at the option of the department. Candidates who do not complete a thesis must present a minimum of 36 graduate units and an acceptable professional paper. Approval for a Master of Science program without a thesis must be obtained no later than nine months after admission to the degree program or within twelve months after provisional admission or admission as an International Special student, whichever is sooner. Supporting work is available in agriculture, animal physiology, biochemistry, biological sciences, chemistry, microbiology, nutrition and food science, physiology, plant sciences, statistics, systems and industrial engineering, veterinary science and in soil and water science.

Graduate programs leading to the Doctor of Philosophy degree are administered by interdepartmental committees: Animal Physiology, Genetics, and Nutritional Sciences.

413. Principles of Animal Breeding (3) GC II Basic concepts involved in the improvement of economically important traits of livestock through application of genetic principles. Field trips. P, 213 or Ecol. 321 or P.S. 228; Math. 117e.


415R. Physiology of Reproduction (3) GC I Study of the organs of reproduction and their accessories; physiology and endocrinology as related to the process of reproduction and milk secretion. P, Chem. 101b, 102b, Ecol. 101a and three units of animal anat.-psio. (Identical with V.Sc. 415R)

415L. Physiology of Reproduction Laboratory (1) GC I Practice in semen collection and storage, artificial insemination, and hormone assay. P or CR, 415R. (Identical with V.Sc. 415L)


436. Applied Animal Nutrition (4) GC II Application of principles of nutrition to the feeding of livestock and poultry, nutrient composition and characteristics of feeds, nutrient requirements and diet formulation. 3R, 3L. P, 430.


463. Food Analysis (3) GC II 1986-87 (Identical with N.F.S. 463)

472. Dairy Herd Management (3) GC I Proper milking, efficient housing, and health management of dairy cattle; marketing milk from the farm; milk production costs. Field trip. P, 430.

473. Swine Production (2) GC I The production, feeding and management of swine in intensive production systems. Field trip. P, 430.

474. Sheep Production (2) GC II The production, feeding and management of sheep on the farm and ranch. 1R, 3L. P, 430.


476. Horse Production (3) GC II Production, feeding, management, reproduction, and business aspects of modern horse management. 2R, 3L. Field trips. P, 415R, 430.
477. **Beef Cattle Production** (2) GC I The production, feeding, and management of beef cattle prior to finishing. Field trip. P, 430.

478. **Feedlot Beef Production** (2) GC II Feeding and management systems of beef cattle in the feedlot. All-day field trips. P, 430, 436.

480. **Composition and Structure of Meat** (2) GC II 1985-86 The detailed structure, growth and biochemical constitution of muscle and its conversion to meat. Field trip. P, 180 and Chem. 103b, 104b. (Identical with N.F.S. 480 )

501. **Animal Growth and Development** (2) II 1986-87 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, N.F.S. 406a or Bioc. 460 or 462a.

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

601. **Bioenergetics** (2) I (Identical with N.F.S. 601 )

609. **Nutritional Biochemistry Techniques** (3) I (Identical with N.F.S. 609 )

622. **Mineral Metabolism** (2) I 1985-86 (Identical with N.F.S. 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, 430, 436; Chem. 241a, 243a.

**ANTHROPOLOGY**


Associate Professors Constance Cronin, Mary Ellen Morbeck, Susan U. Philips, J. Jefferson Reid, Richard A. Thompson, Norman Yoffee, Stephen L. Zegura

Assistant Professors E. Wesley Jernigan, John W. Olsen

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 anthropology core courses and eighteen units in supporting work must be completed. Supporting courses may be chosen from Southwestern 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 advisers.

**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 Paleontology provide opportunities for climatic and chronological studies of special interest to advanced students in archaeology.

400. Processes of Culture Change (3) GC II Intensive investigation of specific theories and varieties of culture change. P, 200.

401. Ancient Mesopotamia (3) GC I 1986-87 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. (Identical with Hist. 401 and Or.S. 401)

402. Kinship and Social Organization (3) GC I Principles in the comparative study of social systems; types of social structure. P, 200, or nine units of soc. (Identical with Soc. 402)

403. Anthropology of Conflict Resolution (3) GC II 1985-86 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. 2R, 3L.

404. Sociology of the Southwest (3) GC I (Identical with Soc. 404)

405. Urban Adaptation of Ethnic Groups (3) GC I 1985-86 A survey of adaptations of ethnic and social groups to urban areas, focusing on a different group or region each semester.

407. Peasant Communities (3) GC I Comparative analysis of traditional and contemporary peasant communities. (Identical with Soc. 407)

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

409. Economic Anthropology (3) GC II Analysis of production, exchange, distribution, consumption, property, economic surplus, inheritance, and types of economic structure. P, 200, or twelve units of econ. (Identical with Econ. 409)

410. Perspectives in Anthropology (3) GC II Designed specifically for nonmajors to provide an introduction to the concepts and methods of anthropology.

411. Anthropology of Religion (3) GC 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. (Identical with Reli. 411)

412. Agricultural Economic Development In Latin America (3) GC II (Identical with A.Ec. 412)

413. Ethnology of the Southwest (3) GC II Culture history and economic, social, and religious institutions of the living people of the Southwest. P, 200.

414a-414b. Indians of the Southwest (3-3) GC S History, arts and crafts, economics, social institutions, religions, and mythology of the present-day Indians of the Southwest.

415a-415b. Southwestern Indian Arts (3-3) GC 415a: Prehistoric utilitarian and aesthetic arts. 415b: The art of the modern Indians of the Southwest. 415a is not prerequisite to 415b. (Identical with A.In.S. 415a-415b and Art. 415a-415b)

416. Contemporary Indian America (3) GC II 1985-86 The historical development and contemporary significance of the reservation system in the life of the Native American of the United States. (Identical with A.In.S. 416)

417. Cultures of Ancient Mexico (3) GC S Archaeological and ethnohistoric survey of the civilizations of ancient Mexico from earliest times to the period of the Spanish Conquest. Field trips. Fee.

418a-418b. Scientific Illustration-Photography (2 to 4 - 2 to 4) GC (Identical with Ecol. 418a-418b)

420a-420b. Contemporary American Culture (3-3) GC II 1985-86 Diverse perspectives on American values as expressed in organization of kinship, space, bureaucracies, media, ethnic groups, religious sects and movements. 420a is not prerequisite to 420b.

422a-422b. Pre-Columbian Art (3-3) GC (Identical with Art. 422a-422b)

423. Peoples of Mexico (3) GC II Cultural background and contemporary economic, social, and religious life of the Indian and mestizo populations of Mexico. (Identical with A.In.S. 423 and M.A.S. 423)

424. Gender and Social Identity (3) GC II Theories of sexual equality and inequality, plus an overview of sex roles and sex status in different types of societies and in different areas of social organization. (Identical with W.S. 424)

425. Ethnology of South America (3) GC I 1985-86 Comparative study of culture and history of South American indigenous peoples, including contemporary situation and Latin American policies toward them. P, 200.

427. Religion and Mythology of Mesopotamia (3) GC II 1985-86 Readings in translation of Sumerian and Babylonian myths and rituals stressing anthropological techniques in the interpretation of Mesopotamian cosmology. P, 100. (Identical with Or.S. 427 and Reli. 427)

428. Anthropology of Law (3) GC II 1986-87 Issues in the anthropology and history of law, focusing on the nature of law in its social context; selected case studies. (Identical with Or.S. 428)

429. Cultures and Societies of Africa (3) GC II Ethnology and social anthropology of African peoples including their ecology, social organization, and systems of thought. P, 200. (Identical with BI.S. 429)

431. Anthropology and Development (3) GC II 1985-86 The role of anthropology in interdisciplinary projects involving economic development and planned change on the national and international levels.

432. Peoples of the Pacific (3) GC I 1985-86 Populations and cultures of Polynesia, Micronesia, and Melanesia; variability of these “natural laboratory” settings in an ecological framework.

433. Advanced Scientific Illustration (4) GC S (Identical with Ecol. 433)

435. Principles of Archaeological Fieldwork (3) GC II Introduction to the principles of archaeological fieldwork, with emphasis on method and theory of survey and excavation. 2R, 3L. P, 235.


437. The Relationship of Early Hominids and Contemporary Faunas (3) GC II 1986-87 The faunal association of contemporary animals and hominids world-wide. Peopling the New World. Methods utilized to analyze fossil assemblages when associated with hominids.

438. Zooarchaeology (3) GC I Animals in relation to man, with emphasis on past cultures, especially in the Southwest; morphology of animal skeletons; identification and interpretation of fragmentary remains.


440. Laboratory in Zooarchaeology (3) GC 1986-87 Fragmentary animal remains are in anthropological interpretation. Diagnostic morphological features; role in cultural interpretation. Analytical techniques; lab. analysis; report preparation. 1R, 6L.

441. Organization of Museums (3) GC I An intensive introduction to museum studies, with emphasis on the history, philosophy, structure, and function of museums.

442. Museum Collections Management (3) GC II Principles and procedures governing the acquisition, documentation, care and use of museum collections. 2R, 3L. P, 441.

443. The Archaeology of Neolithic and Bronze Age Greece (3) GC (Identical with Clas. 443)


446. Introduction to Museum Conservation (3) GC II A basic introduction to the examination of the nature and properties of materials in anthropological collections and their deterioration, restoration, and preservation.

449a-449b. Folklore (3-3) GC (Identical with Engl. 449a-449b)

450. Social Stratification (3) GC I II (Identical with Soc. 450)

451. Archaeology of North America (3) GC I Intensive survey of culture in North America from the time of the initial peopling of the New World to the historic period.
452R. **Archaeology of the Southwest** (3) GC I Development of culture in the prehistoric Southwest from the late Pleistocene to the historic period. Field trip.

452L. **Archaeology of the Southwest** (3) GC II The nature of archaeological data recovered in the Southwest, with emphasis on their potential for the drawing of both cultural and chronological inferences. P, 452R.

453. **Mesoamerican Archaeology** (3) GC I Development of culture in Mexico and Central America from the early hunters and gatherers through the conquest of the Aztecs and Mayas by the Spanish. (Identical with M.A.S. 453)

454. **Andean Archaeology** (3) GC II Development of culture in the Andean countries of South America from hunters and gatherers of the terminal Pleistocene through Inca civilization.


456. **Old World Prehistory** (3) GC II Man's cultural development in the Old World, as revealed by prehistoric archaeology, from earliest evidence through the development of agricultural villages.

457. **Prehistoric Mesopotamia** (3) GC I 1985-86 Theories of the rise of civilization tested against archaeological data from Mesopotamia with comparative material from other areas. Time period: end of the Paleolithic to historic (Sumerian) civilization. (Identical with Or.S. 457)

459. **Historical Archaeology** (3) GC II Survey of the basic data and methods of research in the material culture of modern history. The New World from first European contacts to the 20th century. (Identical with Hist. 459)

461. **Race and Ethnic Relations** (3) GC II (Identical with Soc. 461)

462. **Introduction to Quaternary Ecology** (3) GC I (Identical with Geos. 462)

464a-464b. **Introduction to Dendrochronology** (3-3) GC (Identical with Geos. 464a-464b)

465. **Women in International Development** (3) GC I 1985-86 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 W.S. 469; F.C.R. 469)

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

468. **Human Osteology** (3) GC I Human osteology for the archaeologist and physical anthropologist; techniques of in situ and laboratory identification, preservation and measurement. P, consult dept. before enrolling.

470a-470b. **Human Adaptability** (3-3) GC Study of human adaptability focusing on physiological plasticity, growth, nutrition, population ecology, demography, epidemiology and paleopathology. P, 265 or consult dept. before enrolling. 470a is not prerequisite to 470b. (470a identical with Gero. 470a)

471. **Introduction to Indic Civilization** (3) GC I (Identical with Or.S. 471)

473. **Primate Anatomy** (4) GC I 1985-86 Comparative primate functional anatomy from an anthropological viewpoint including extensive laboratory dissection and study of behavior, ecology, and evolution. P, 265 or consult dept. before enrolling.

474R. **Ethnobotany** (3) GC II Survey, with emphasis on cultural uses of plants, both past and present; discussions of contributions to the theory and techniques of the emergence of agriculture, archaeological botany, ethnomedicine, and other aspects of ethnobotany. P, eight units of biology or anthropology.

474L. **Ethnobotany Laboratory** (1) GC II Field-lab course treating sampling, processing, storage, and identification techniques, procedures, and interpretation in selected areas of ethnobotany. Field trips. P, eight units of biology or anthropology.

475. **Origins and Development of Cultivated Plants** (3) GC I Evaluation of theories of origins and early development of cultivated plants in general, with attention given to crop plants of world-wide economic importance and selected crops of local economic importance. Three-day field trip. P, Ecol. 321.

476. **Language in Culture** (3) GC II Survey of the nature of the interrelationships between language and other cultural phenomena. P, 276. (Identical with Ling. 476)

477. **Discourse and Text** (3) GC 1985-86 Analysis and cross-cultural comparison of patterns of communication in discourse; modern approaches to discourse and text. P, 276, Ling. 200 or consult department before enrolling. (Identical with Ling. 477)
108 DEPARTMENTS AND COURSES OF INSTRUCTION

480. Historical Comparative Linguistics (3) GC I Types and mechanisms of linguistic change; language and dialect formation; determination of prehistorical relationships; reconstruction of proto-languages and cultures, and their origins in time and space. P, 276. (Identical with Ling. 480)

481a-481b. Archaeology of Syria-Palestine in the Bronze and Iron Ages (3-3) GC (Identical with Or.S. 481a-481b)

482. Hopi Language in Culture (3) GC II A conversational introduction to Third Mesa dialect of Hopi, with emphasis on cultural context and covering essentials of Hopi language structure. (Identical with A.In.S. 482)

484a-484b. Akkadian Linguistics (3-3) GC 1986-87 Introduction to the standard literary language of the Babylonians and Assyrians. (Identical with Or.S. 484a-484b)

485. Social Organization of India and Pakistan (3) GC I (Identical with Or.S. 485)

486. Comparative Community Development (3) GC I (Identical with Soc. 486)

487. Poverty and Health (3) GC II (Identical with Nurs. 487)

489. Anthropology and Education (3) GC I II (Identical with Ed.F.A. 489)

495. Colloquium a. Bilingual Health Communication (3) GC II (Identical with Nurs. 495a)

496. Workshop g. The Archaeology of Pre-Han China (3) GC II P, 100 or consult department before enrolling. (Identical with Or.S. 496g)

j. The Prehistory of East Asia (3) GC I P, 100 or consult department before enrolling. (Identical with Or.S. 496j)


501a-501b. Medical Anthropology (3-3) Focuses on the sociocultural and biological dimensions of medical systems, institutions, and behaviors in modern and developing societies relating to ethnic, tribal, and peasant populations. 501a is not prerequisite to 501b. Consult department before enrolling.

502a-502b. Dynamics of Indian Societies (3-3) (Identical with A.In.S. 502a-502b)

514. Late Quaternary Geology (3) I 1986-87 (Identical with Geos. 515)

524. Theoretical Population Genetics (3) I (Identical with Ecol. 524)

561. Paleoindian Origins (3) I Chronological development of Paleo-Indian occupation of the New World; site discovery, case studies, development of theories on origins and impact of early man on the environment. (Identical with Geos. 561)

580a-580b. Anthropological Linguistics: Field Methods (3-3) 580a: Experience in doing descriptive linguistics. 580b: Experience in doing ethnographic semantics. 580a is not a prerequisite to 580b.

581. Quaternary Palynology (4) II (Identical with Geos. 581)

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

584a-584b. Readings In Akkadian (3-3) 1985-86 Readings in selected literary, religious and economic texts designed not only to improve language mastery but to use those documents in elucidation of specific topics in Mesopotamian culture. P, 484a-484b. (Identical with Or.S. 584a-584b)

588. Clinical Anthropology (3) I II (Identical with Nurs. 588)


b. Pre-Columbian Art (3) [ Rpt./4] I (Identical with Art. 596e, which is home)

c. Near Eastern Archaeology (3) [ Rpt.] II (Identical with Or.S. 596q, which is home)

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

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

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

600a-600b. Foundations of Cultural Anthropology (3-3) An intensive introduction to social and cultural anthropology, with emphasis on theories and concepts of culture, society, and the individual. Open to majors only.
604. Educational Administration in Anthropological Perspective (3-3) An intensive introduction to archaeology. 635a: Major problems in the culture sequence. 635b: Methods and concepts. Open to majors only.

640. Archaeological Research Design (3) I Methodological considerations of designing experimental, ethnoarchaeological, and prehistoric research, with emphasis on cultural resource management studies. P. 436, 635a-635b.

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

645. Early Civilizations (3) II Comparative analysis of early civilizations from both the Old World and the New World, with emphasis on regularities in cultural development. P, 457, 456, 454 or 650.

650. Ancient Civilizations of Mesoamerica (3) 1985-86 Comparative study of cultural development in Mesoamerica, with emphasis on agricultural beginnings, settlement pattern and urbanization, hieroglyphic writing, and calendrical systems.


679. Language and Ethnography (3) II 1986-87 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 videotaping. P, six units of ling.

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

696. Seminar
   a. Archaeology (1 to 3) I II
   b. Cultural Anthropology (1 to 3) I II
   c. Linguistic Anthropology (1 to 3) I II
   d. Physical Anthropology (1 to 3) I II
   e. Museology (1 to 3) I II

APPLIED MATHEMATICS

Committee on Applied Mathematics

Associate Professors Gregory R. Baker (Mathematics), William Filippone (Nuclear & Energy Engineering), Barry C. Ganapol (Nuclear & Energy Engineering), Olgierd Palusinski (Electrical and Computer Engineering), Tudor Ratiu (Mathematics), Randall Richardson (Geosciences), Moshe Shaked (Mathematics), Malur K. Sundareshan (Electrical Engineering)

Assistant Professors K. Y. Fung (Aerospace & Mechanical Engineering), Juan C. Heinrich (Aerospace & Mechanical Engineering), Chris K. Jones (Mathematics), Edward J. Kerschen (Aerospace & Mechanical Engineering), Daniel I Meiron (Mathematics), Richard E. Michod (Ecology and Evolutionary Biology), John Palmer (Mathematics), Timothy W. Secomb (Arizona Research Laboratories)

The committee offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in applied mathematics.

The program in applied mathematics encourages and supports cross-disciplinary research covering a broad spectrum of disciplines in science, engineering and business in which mathematics and modeling play fundamental roles. Students have considerable flexibility in the design of their individual programs. The program attempts to draw out from young men and women their ability to think maturely and more laterally and to train them in all facets of modern applied mathematics. Standards are high but the rewards are great, and graduates have made successful careers in industry and academia.

For both the master's and doctoral degrees, student programs are quite flexible and individually designed. Essentially, their basic structures involve a selection of some foundation courses in mathematics, a number of other courses both inside and outside the Department of Mathematics, and participation in a problem seminar. Entering students are expected to know advanced calculus and basic probability theory, although they can take such courses as graduate students. The foundation courses include numerical analysis, ordinary differential equations, statistics, stochastic processes, and methods of applied mathematics. In the problem seminar, different faculty members (primarily nonmathematicians) present in-depth analysis of problems arising in their research.

A doctoral dissertation in applied mathematics applies mathematics to a problem arising in an applied discipline or develops mathematical methods for a class of such problems.

Those interested in detailed information about requirements and examinations should contact the committee.

Committee members are currently involved with a variety of research activities, many benefiting from interdisciplinary cooperation. Subjects currently include aerodynamics, analysis of algorithms, applications of Markov processes, applications of theoretical computer science, astrophysical plasma physics, asymptotic methods, biological modeling, boundary layer theory, calculus of variations, combinatorial optimization, cosmic rays, differential equations, differential games, digital image processing, dynamic meteorology, ecology, economics of uncertainty, eigenvalue problems, electrical geophysics, electromagnetic theory, evolution of reproductive strategies, experimental economics, feedback systems, fluid dynamics, fusion devices, gauge field theory, heavy ion reaction theory, human problem solving, hybrid computation, image processing, integral and functional equations, interactive computer graphics, laser theory, limit theorems for probability, mathematical ecology, mathematical modeling and political violence, mathematical physics, mathematical programming, microcirculation, microeconomic theory, networks, non-experimental research design, nonlinear optimization, nonlinear optics, nonlinear partial differential equations, nonlinear wave propagation, non-numerical computing, nuclear many-body theory, nuclear reactor analysis and safety, numerical analysis, numerical modeling, operations research, operator theory, optical pulse propagation, optimal control, parameter estimation, particle transport theory, pattern recognition, perturbation methods, pharmacokinetics, physiological fluid mechanics, plasma physics, population dynamics, power plant simulation dynamics, probability theory, quantum electronics, quantum mechanics, quantum optics, radio astronomy, reaction-diffusion equations, reactor dynamics, relativity, signal processing, simulation, singular perturbations, soil mechanics, statistics, statistical mechanics, stochastic equations, structure of finite nuclei, system identification, systems theory, tensor calculus, and wave propagation.
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.

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

412. **Advanced Graphics** (3) GC I Advanced graphics, with specific emphasis on photographic techniques for use in portfolio preparation; general review of professional public relations presentation techniques. 2R, 6L. P, 222b, 302.

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

414. **History of Architecture: American Architecture** (2) GC II Developments in American architecture from the colonial to the early modern period. P, six units of art hist. or arch. hist. Nonmajors may petition to enroll.

422. **Process and Synthesis In Design** (3) GC II Traditional and contemporary models of concept formation in design, including a study of their underlying assumptions and values. P, 302.

428. **Field Methods in Environmental Psychology** (3) GC II (Identical with Psyc. 428)

429. **Pre-Design Services** (3) GC I Principles and operations of gathering, analyzing, interpreting, translating and presenting information and ideas pertinent to architectural design. P, 302.

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

439. **Construction Documents** (3) GC II Content, intent, functions and practice of preparing documents needed for various construction delivery systems. 2R, 3S. P, 302.

444. **Site Planning** (2) GC II Studies relating to design determinants for development of outdoor space. P, 302.

449. **Construction Quality Assurance** (3) GC II Theory and practice of specifying, text editing and cost forecasting; both manual and automated. P, 270 or M.I.S. 111. Nonmajors may petition to enroll.

451. **Topics In Architecture** (6) GC Studio work in one of the following: building design, community design, design development, historic preservation, design technologies, economics and politics in architecture, housing design, design in arid regions, and energy-conscious design. Offerings are limited by faculty availability, and all topics may not be offered each year. Other topics may be introduced. P, 335, 336, 338b, 424b, 402.

452. **Senior Project** (6) GC Studio-based project related to one of the topics in 451. The program for the senior project must be completed and approved prior to enrollment. P, 451.

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

463. **Introduction to the Delivery Process and Economics of Housing** (3) GC I The architect's role in the development of housing as related to economic considerations and the overall housing industry's delivery process. Field trips.

470. **Computer Applications In Architecture** (3) GC II Applying computer technology to the architecture profession. P, 302.
473. Introduction to the Conservation of Cultural Resources (3) GC 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.

474. Environmental Planning (2) GC 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 424b.


497. Workshop
i. Community Design for Non-Designers (3) GC I Field trips. Open to nonmajors only. (Identical with L.Ar. 497i)

596. Seminar
a. Readings in Architecture (2) [ Rpt.] III Open to majors only.
u. Interdisciplinary Environment- Behavior- Design (3) I (Identical with ldis. 596u, which is home)

597. Workshop
a. Architecture (3 to 8) [ Rpt. ] III Open to majors only.

ARID LANDS RESOURCE SCIENCES

Committee on Arid Lands Resource Sciences (Graduate)

Professors Robert B. Bechtel (Psychology), Stanley N. Davis (Hydrology and Water Resources), C. John Marè (Veterinary Science), Paul S. Martin (Geosciences), Richard W. Reeves (Geography and Regional Development), Ervin H. Zube (Renewable Natural Resources)

Associate Professors Michael E. Bonine (Oriental Studies), James C. Wade (Agricultural Economics)

Assistant Professor Charles F. Hutchinson, Chairperson, (Arid Lands)

The Committee on Arid Lands Resource Sciences offers programs leading to the Doctor of Philosophy degree (but not the master's degree) with a major in arid lands resource sciences. Special interdisciplinary concentrations combining aspects of the biological, physical, and social sciences, not available in the usual major-minor degree programs, may be used by advanced students with promising research projects and strong interests in arid lands.

Interested students should communicate with the chairperson of the Arid Lands Resource Sciences Doctor of Philosophy program, presenting a brief summary of their career goals and proposed dissertation research areas.

Following admission, the study program will be arranged and supervised by a committee of appropriate faculty members. Doctoral students with majors in other fields may use arid lands resource sciences as a minor field.

ART


Assistant Professors Jackson Boelts, Joan A. Holladay

The department offers programs leading to the Master of Fine Arts degree with a major in art and the Master of Arts degree with a major in art history or art education.

Admission to advanced degree programs requires appropriate undergraduate preparation at this institution, or one of similar standing, not more than ten years prior to the date of entry.
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 adviser, 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 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 except by special permission. 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) — Applicants must have completed an undergraduate program in art education or in art with a teaching credential in art. Slides or photographs of previous studio work must be submitted directly to the Department of Art before admission can be considered.

All students must complete at least 12 units in studio courses or in art history courses and 15 units in art education courses including Art 433 or 434, and 633. Each student may elect to take 3 units of 910, or in lieu of thesis, 3 units of 900. A final oral examination is required.

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 University of Arizona Museum of Art schedules exhibitions from these collections and, from time to time, other exhibitions of general or special interest.

405. Figure Drawing III (3) [Rpt./5] GC I II Advanced drawing with emphasis on personal expressive development. 6S. P, six units of 305.

409. Drawing Critique (3) [Rpt./5] GC I II Individual exploration and development of visual concepts through drawing, accompanied by individual and class critiques. P, six units of 405.

441. Advanced Photography (3) [Rpt.] GC I II Current trends, philosophies and experimentation in still photography. 2R,2S. P, acceptance of portfolio by Portfolio Committee.


447. Mixed Media Book (3) [Rpt./1] GC 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, 2S. Field trips. P, twelve units of studio art courses.

452. Advanced Lithography (3) [Rpt./5] GC I II Autographic lithography as personal creative medium and professional skill; multiple-color printing with emphasis on controls and quality. 6S. Field trips. P, 352.

454. Advanced Relief and Intaglio (3) [Rpt./5] GC I II Traditional modes of relief block and intaglio plate printmaking expanded via individual research and experiment; emphasis on development of personal aesthetic and professional standards. 6S. Field trips. P, 251.
465. **Portfolio Preparation (3)** [Rpt./1] GC 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. 6S. P, nine units of graphic design courses and approval of portfolio by Portfolio Committee.

466. **Editorial Illustration (3)** [Rpt./1] GC I Problems in editorial and book illustration. 6S. P, 9 units of illustration courses and approval of portfolio by Portfolio Committee.

468. **Graphic Design Studio (3)** [Rpt./1] GC I Classroom experience in a professional designer capacity with studio solutions to graphic design problems submitted from campus and community. 6S. Field trips. Consult dept. before enrolling. P, nine units graphic design courses, acceptance of portfolio by Portfolio Committee.


471. **Advanced Jewelry and Metalsmithing I (3)** [Rpt./4] GC I Advanced study of the various materials and methods in the construction of jewelry and metalwork. 6S. P, nine units of metalwork.


473. **Advanced Ceramics (3)** [Rpt./5] GC I Individual studio research and instruction, with emphasis on personal creative development. 1R, 4S. P, 373.

476. **Advanced Fibers (3)** [Rpt.] GC II Individual interpretations of concept into finished fiber works. P, 176; 9 units of intermediate fibers.

480. **Painting III (3)** [Rpt./5] GC I II Advanced painting concepts, with emphasis on personal expressive development and change. 6S. P, six units of 380.

481. **Readings in Contemporary Art (3)** GC I Discussion of contemporary art and artists, based upon assigned readings and slide presentations. Field trips.

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


486. **Advanced Design in Wood (3)** [Rpt./4] GC I II Advanced design and fabrication of wood products, both utilitarian and sculptural. 6S. P, 286.


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. 6S.

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

565. **Graduate Graphic Design Problems (3)** [Rpt./1] I II Two- and three-dimensional design considerations with emphasis on conceptualization and presentation. 6S. Field trips. P, acceptance of portfolio by Portfolio Committee.

567. **Graduate Illustration (3)** [Rpt./1] I II Exploration of any optical material or phenomenon as a possible solution to illustration problems. 6S. Field trips. P, acceptance of portfolio by Portfolio Committee.

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. 6S.

581. **Intermedia Studio (3)** [Rpt.] I Individual and group projects incorporating elements of vision, sound, dance, drama, literature; access to camera, tape recorder is helpful. Field trips.

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

596. **Seminar**

p. Photography and Language (3) [Rpt./1] II 2R, 2S. Open to majors only.

s. 3-D Concepts (3) [Rpt./1] II

597. **Workshop**

I. Contemporary Photographic Ideas (3) [Rpt./1]
642. **Studio Photography Critique** (3) [Rpt./5] I II Investigation of practical methods of critique and their influence on an artist's developing body of work. Limited to art majors with photography concentration.

671. **Graduate Jewelry and Metalsmithing** (6 to 10) [Rpt./6] I II Graduate study in all phases of jewelry and metalwork. 12 to 20S.

673. **Graduate Studio in Ceramics** (6 to 10) [Rpt./6] I II Studio research and instruction with emphasis on personal creative development. 12 to 20S. Field trips. P, 473.

676. **Graduate Fiber Studies** (6 to 10) [Rpt./6] I II Graduate experimentation in all aspects of fiber work, with emphasis on the development of a personal style within the medium. 12 to 20S. P, 476.

680. **Graduate Studio** (6 to 10) [Rpt./6] I II P, twelve units of grad. credit in art.

687. **Graduate Problems in Sculpture** (3) [Rpt./6] I II Personal response to form and composition using a variety of technical means including welding, casting, carving and nontraditional techniques. 6S. P, 487.

**Art History Courses**

411. **Roman Art and Architecture** (3) GC The origin and development of Italian art and architecture from Etruscan beginnings through the Republic to the late Empire. P, both surveys (117, 118) or six units of ancient hist. (Identical with Clas. 411)

412a-412b. **Medieval Art** (3-3) GC 412a: II Arts of the nomadic invasions of Western Europe and Hiberno-Saxon, Merovingian, and Carolingian art. 412b: I 1986-87 Survey of Ottonian, Romanesque, and Gothic art from A.D. 1000 through 1250. 412a is not prerequisite to 412b.

413a-413b-413F. **Renaissance Art in Italy** (3-3-6) GC Painting, sculpture and architecture in Italy. 413a: I 13th-15th centuries. 413b: II High Renaissance to 1600. 413F: S Art of Florence, 13th-15th centuries. Offered in Florence only. P, six units of hist. or art hist. 413a is not prerequisite to 413b or 413F.

414a-414b. **Netherlandish Art** (3-3) GC 414a: Development of painting in the Netherlands and France from the 14th through the 16th centuries. 414b: Painting, sculpture, and architecture in Holland and Flanders. P, six units of hist. or art hist. 414a is not prerequisite to 414b.

415a-415b. **Southwest Indian Arts** (3-3) GC (Identical with Anth. 415a-415b)

417a-417b. **19th-Century European Art** (3-3) GC Painting and sculpture. 417a: From the French Revolution to about 1850. 417b: From about 1850 through Impressionism. P, six units of hist. or art hist.

418a-418b. **20th-Century Art** (3-3) GC Painting and sculpture in Europe. 418a: 1866 to World War I. 418b: Between the World Wars. P, six units of hist. or art hist. 418a is not prerequisite to 418b.

422a-422b. **Pre-Columbian Art** (3-3) GC 422a: Art of the high cultures of Mesoamerica, with the focus on architecture, sculpture, painting and crafts prior to European contact. 422b: Pre-Columbian art of Central and South America, with particular attention to the Andean area. 422a is not prerequisite to 422b. (Identical with Anth. 422a-422b)

424a-424b. **History of Photography** (3-3) GC 424a: From its invention to 1895; impact of photography on the art and culture of the 19th century. 424b: As an art medium from 1895 to 1965. P, six units of art hist. 424a is not prerequisite to 424b.

426a-426b. **German Art** (3-3) GC Painting, graphics, architecture and sculpture. 426a: German Renaissance, Baroque, Classical, Romantic, and Modern Germany. P, six units of hist., art hist., or Ger. 426a is not prerequisite to 426b. (426b is identical with Ger. 426b)

428. **17th- and 18th-Century Art in Italy and France** (3) GC Painting, architecture, and sculpture of the Baroque and subsequent periods. P, six units of hist. or art hist.

429a-429b-429c-429d. **American Art** (3-3-3-3) GC Art in the United States. 429a: Colonial art. 429b: 19th century art. 429c: From 1900 through 1940. 429d: Twentieth century American art from the 1930's to recent times. May be taken in any order. P, six units of hist. or art hist.

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.

512. **Early Christian and Byzantine Art and Architecture** (3) I An historical analysis of artistic changes from paleo-Christian time through the last stages of the Byzantine style. P, both surveys (117, 118) or six units of hist.
DEPARTMENTS AND COURSES OF INSTRUCTION

596. Seminar
a. American Art (3) [ Rpt./2] I II
b. Problems in Renaissance-Baroque (3) [ Rpt./2] II
c. Studies in Medieval Art (3) [ Rpt./2] I II
e. Pre-Columbian Art (3) [ Rpt./4] I Consult instructor before enrolling. (Identical with Anth. 596e )
f. History of Photography (3) [ Rpt./4] I II P, 424a or 424b.
g. Colonial and 19th-Century American Art (3) [ Rpt./3] I 1986-87 Field trips.

693. Internship
a. Art Museum Training (1 to 6) [ Rpt./12 units] I II Open to students concentrating in museum studies only. P, twelve units of grad. art hist. courses.
b. Curatorial Training for Archives of Photography (1 to 6) [ Rpt./12 units] I II Open to students concentrating in museum studies only. P, 511, twelve units of grad. art hist. courses.
c. Archivist Training for Collection of Photography (1 to 6) [ Rpt./12 units] I II Open to students concentrating in museum studies only. P, twelve units of grad. art hist. courses.
d. Archives of Photography: Preservation/Cataloging (1 to 6) [ Rpt./12 units] I II Open to students concentrating in museum studies only. P, 511, twelve units grad. art hist. courses.

696. Seminar

Art Education Courses


433. Art in Society (3) GC II Analysis and interpretation of influences, attitudes, and concerns involving the relationship of art and artists to contemporary society.

434. Environmental Aesthetics (3) GC I Critical analysis and interpretation of visual forms, their content and varying styles, in the everyday, man-made environment.

435. Art and Visual Perception (3) GC II Theories of visual perception in relation to the pictorial process and the study of vision as a perceptual system: the eye, color, space, illusion, perceptual learning, current research.

436. Community Arts Careers (3) GC I Structure and function of community arts agencies with emphasis on their relationship to art education theory and practices.

438. Art Criticism in Art Education (3) GC Methods of analyzing art works and aesthetic experiences appropriate to art classroom teaching. Videotapes, films, and readings illustrate concepts and terminology.

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.


630. History and Philosophy in Art Education (3) Critical examination of literature containing fundamental concepts that have shaped the development, scope, and current significance of art education.

633. Issues and Recent Research in Art Education (3) I The identification of problems in art education at various curricular levels; examination of related research with possible implications for practice. P, S.Ed. 493a (in art), or teaching experience.

696. Seminar
c. Contemporary Art and Art Criticism (3) [ Rpt./2] I 1985-86.

Associate Professors Marc Aaronson, John Black, William J. Cocke, Charles J. Lada, James W. Liebert, Andrzej G. Pacholczyk, Marsha Rieke, Raymond E. White, Simon White

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 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. One foreign language is recommended but not required. A final oral examination is required.

For the Doctor of Philosophy degree the language requirement may be satisfied with Russian, German, or French.

Successful completion of the introductory course sequence [(515, 502 522, 575) or (540, 535, 585) alternate years] , as well as 3 graduate physics courses, constitutes demonstration of qualification 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 including at least 6 units at the 500 level.

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 magnetohydrodynamics and general relativity applied to astrophysical problems.

400a-400b. **Theoretical Astrophysics** (3-3) GC Stars, interstellar matter, galaxies, radio sources, cosmology. P, Math. 254, six units upper-division phys.

403. **Introduction to the Solar System** (3) GC I (Identical with Pty.S. 403)

404. **Man's Exploration of the Solar System** (3) GC S (Identical with Pty.S. 404)

502. **Introductory Astronomical Instrumentation and Technique** (3) I 1986-87 Survey of instrumentation and techniques applicable to astronomical problems; noise sources, mechanical and optical technology, spectrum analyzers, polarimetry, image analyzers, video and electronic techniques.

515. **Gaseous Nebulae and the Interstellar Medium** (3) II 1986-87 Ionization equilibrium; heating and cooling of HI and HII regions; determination of physical conditions from emission-line spectra; dark and reflection nebulae; interstellar grains.

518. **Experimental Methods of Planetary Science** (3) I 1985-86 (Identical with Pty.S. 518)


535. **Stellar Structure** (3) II 1985-86 Virial theorem; gas spheres in hydrostatic equilibrium; polytropes; convective and radiative equilibrium; equations of state; opacities; nuclear reaction rates; stellar model computation; stellar atmospheres and evolution. Strittmatter

540. **Basic Properties of Galaxies** (3) II 1986-87 Classification, mass determination, photometric properties, dust and gas content, stellar content, systems and clusters, distance scales, galactic dynamics. Tifft/Strittmatter

545. **Stellar Atmospheres** (3) I 1985-86 Radiative transfer, gray atmosphere, opacity, line formation, non-LTE, curves of growth, stellar hydrodynamics.

551. **Satellite and Planetary Perturbation Theory** (3) II (Identical with Pty.S. 551)

556a-556b. **Electrodynamics of Conducting Fluids and Plasmas** (3-3) 1986-87 (Identical with Pty.S. 556a-556b)

575. **General Relativity and Cosmology** (3) II 1986-87 General relativity, with applications to cosmology and stellar structure; formation of stars and galaxies. Cocke/Weymann


**ATMOSPHERIC SCIENCES**

Professors William D. Sellers, Heed, Louis J. Battan, George A. Dawson, Robert L. Gall, Benjamin M. Herman, E. Philip Krider, Richard M. Schotland, Dean O. Staley, Sean A. Twomey

Associate Professor Kenneth C. Young

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in atmospheric sciences. In conjunction with the facilities of the Institute of Atmospheric Physics, concentrations are available in physical meteorology, physical climatology, atmospheric electricity, atmospheric radiation, atmospheric chemistry, and atmospheric dynamics.
An undergraduate major or minor in meteorology is not required for admission but some knowledge of the field is desirable. Applicants with undergraduate majors in physics are particularly encouraged to apply.

Degrees

MASTER OF SCIENCE — 30 units of graduate work, including Atmo. 441a-441b, Atmo. 451a, and three 500 or 600-level atmospheric sciences courses, are required. All candidates must submit a thesis or a manuscript which has been judged by the student's committee to be acceptable for publication in an approved scientific journal and must pass a comprehensive written examination in the major field.

DOCTOR OF PHILOSOPHY — In addition to the College requirements, the candidate must demonstrate a reading knowledge of a foreign language approved by his or her committee.

421. Physical Climatology (3) GC 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.

427. Bioclimatology (3) GC II Description and analysis of the environmental boundary layer and its interaction with animal and plant life. Models are developed for energy and mass transfer in this region. P, 171. (Identical with Ws.M. 427)

441a-441b. Dynamic Meteorology (3-3) GC Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. P, Phys. 121; Math. 254.

450. Air Pollution Meteorology (3) GC II 1986-87 Theoretical description and experimental practice relating to the dispersion of gases and particulate matter in the atmosphere. Attention given to the scales of dispersion and the scales of atmospheric turbulence as related to local, regional and global pollution. P, 300 or consult department before enrolling.

451a-451b. Physical Meteorology (3-3) GC Introduction to atmospheric physics, including atmospheric radiation, fluid mechanics, aerosol physics, cloud physics, and atmospheric electricity. P, Phys. 121; Math. 254.

465. Mesoscale Meteorology (3) GC II 1985-86 Description and dynamics of weather systems of the mesoscale. Topics may include fronts, thunderstorms, gravity waves, lake effect storms and sea breezes. P, 300.

471. Synoptic Analysis (3) GC I 1986-87 Principles of meteorological analysis, including surface and upper-level charts, cross-sections, kinematic analysis, structure of the troposphere and tropospheric systems, thermodynamic diagrams. 1R, 6L. P, CR 441a, or 300.

472. Weather Forecasting (3) GC II 1986-87 Techniques for weather forecasting and actual forecasting experience; advanced synoptic analysis. 1R, 6L. P, 471.

489. Sunlight and Skylight (3) GC II 1985-86 The nature of the sun and solar radiation. Optical phenomena in the atmosphere such as mirages, rainbows, haloes, and glories. P, 451a.


530. Micrometeorology (3) I 1985-86 Theoretical aspects of atmospheric turbulence, including discussions of laminar flow, turbulent flow, the mechanical energy equations, and the shearing stress and the wind profile. P, 441b.

535. Air/Sea Interactions (3) I 1986-87 Physical characteristics of the oceans; the dynamics of ocean currents and their interactions with the atmosphere; El Niño and other teleconnections between the oceans and the atmosphere. P, 300.

544. Physics of the High Atmosphere (3) II 1985-86 (Identical with Pty.S. 544)

555. Computational Methods for Radiative Transfer (3) I 1986-87 An introduction to numerical methods used in radiative transfer calculations. P, 556 or Phys. 420 or Math. 422 or Opti. 552.

561. Radar Meteorology (3) I 1985-86 Propagation, scattering, and attenuation of microwaves in the atmosphere and the use of radar for observing clouds, precipitation, thunderstorms, tornadoes and other meteorological phenomena.

575. Atmospheric Aerosols (3) I 1985-86 Physics, mechanics, and optics of individual atmospheric aerosol particles. Topics include formation dynamics, nucleation and growth, coagulation, scattering and absorption of radiation.
585. Tropospheric Chemistry (3) I 1985-86 A study of tropospheric chemistry, with emphasis on the controls and feedbacks involving the major constituents, the cycles of the minor constituents, methods of measurement, and applications.


595. Colloquium a. Atmospheric Measurement Techniques (1 to 3) II 1985-86


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, 441b.


656a-656b. Atmospheric Optics and Radiation (3-3) 1986-87 Theory of atmospheric radiative transfer processes; specific methods for solving relevant equations; applications to problems in radiative transfer and optics. P, Phys. 420. (Identical with Opti. 656a-656b)

683. Principles of Atmospheric Remote Sensing (3) II 1986-87 For remote sensing applications, mathematical methods are developed to infer the physical properties of the atmosphere. Techniques using optical and microwave frequencies are examined for their information content. P, 656b; Math. 254. (Identical with E.C.E. 683)

BILINGUAL/BICULTURAL EDUCATION
(See Educational Foundations and Administration)

BIOCHEMISTRY


Associate Professors Hans J. Bohnert, Don P. Bourque, Wah Chiu; William J. Grimes, Jennifer D. Hall (Molecular and Cellular Biology), Martinez J. Hewlett (Molecular and Cellular Biology)

Assistant Professors Danny L. Brower (Molecular and Cellular Biology), James F. Deatherage, Carol Dieckmann, Nancy W. Downer, John W. Little, Ivan Rayment, Marc E. Tischler

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 only 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.


462a-462b. **Biochemistry** (4-3) GC Introduction to the properties and metabolism of proteins, nucleic acids, enzymes, carbohydrates and lipids. Designed primarily for majors and minors in chem., biol, and biol. P, Chem. 241b, 325. (Identical with Chem. 462a-462b and Tox. 462a-462b)

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

473. **Recombinant DNA Techniques** (3) GC II (Identical with M.C.B. 473)

501. **Medical Biochemistry** (5) I Comprehensive treatment of general biochemistry, oriented towards human biology, with emphasis on basic concepts; protein and nucleic acid chemistry and metabolism, enzymology, metabolism of lipids and carbohydrates, metabolic regulation and closely related topics. P, Chem. 103b, 104b, 241b, 245b; Phys. 102b.

504. **Intermediate Medical Biochemistry** (5) I An intermediate treatment of several areas of general biochemistry including metabolism and nutrition, genetics and membranes. Designed to build on the student's prior knowledge of biochemistry. Consult dept. before enrolling. P, 462a-462b.

561a-561b. **Introduction to Biochemical Literature** (1-1) Designed to supplement 462a-462b with a more detailed consideration of subject matter of lectures. Primarily for those students planning a career in bioc. and wishing to prepare themselves for future grad. study. P, CR 462a-462b. 561a is not prerequisite to 561b. (Identical with Chem. 561a-561b)


569. **Structure and Function of Biological Membranes** (3) II 1986-87 Physical and chemical properties of membranes and membrane components, photosynthesis, vision. P, 462b. (Identical with Chem. 569)

570. **Molecular Biology of the Cell Membrane** (3) I 1985-86 Cell membrane functions including biosynthesis, structures of membrane components; importance of cell communication, differentiation, adhesion, immune response, and cancer. Discussions on the use of monoclonal antibodies, recombinant DNA technology, and DNA transfections in studies on the biology of the cell membrane. (Identical with Chem. 570 and M.C.B. 570)


595. **Colloquium**
   b. Topics in Electron Microscopy (2) [ Rpt./2] 1985-86 II (Identical with M.C.B. 595b, which is home)

617. **Steroid Chemistry and Biochemistry** (3) I 1986-87 (Identical with N.F.S. 617)

665. **Chemistry of Food Proteins** (3) II 1985-86 (Identical with N.F.S. 665)

681. **Introduction to Biochemical Research** (1 to 2) 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 to 3) I
   b. Biochemistry II (1 to 3) II

800. **Research** (1 to 16) Yr.
801. Medical Biochemistry (5)
804. Intermediate Medical Biochemistry (5)

BIOLOGICAL SCIENCES

Graduate work and research in the biological sciences are carried out in a number of different locations at the University of Arizona. For information concerning degree programs see the following headings elsewhere in this catalog:

Anatomy
Animal Physiology
Animal Sciences
Biochemistry
Ecology and Evolutionary Biology
Entomology
Genetics

Microbiology and Immunology
Molecular and Cellular Biology
Nutritional Sciences
Physiology
Plant Pathology
Plant Protection
Plant Sciences
Renewable Natural Resources

In addition, a number of other departments offer graduate work in areas related to the biological sciences but more closely associated with professional health care. Among these are:

Engineering (biomedical option)
Nursing
Nutrition and Food Science
Pharmaceutical Sciences

Pharmacology
Pharmacology and Toxicology
Pharmacy Practice
Speech and Hearing Sciences
Toxicology

BIOMEDICAL ENGINEERING
(See Engineering)

BOTANY
(See Ecology and Evolutionary Biology)

BUSINESS ADMINISTRATION

Committee on Business Administration
Professors William B. Barrett (Associate Dean, Academic Affairs), Chairperson, Gerald O. Bierwag (Finance and Real Estate), Averill M. Law (Management Information Systems), Richard O. Mason (Management Information Systems)
Associate Professors David A. Conn (Economics), Melanie R. Wallendorf (Marketing)
Assistant Professors Margaret A. Neale (Management and Policy), William S. Waller (Accounting)

The committee offers programs leading to the Master of Business Administration and the Doctor of Philosophy degrees with a major in business administration. These programs are designed to meet the demands for teachers, consultants, and management personnel trained in the application of scientific research to business problems.

All applicants are required to submit scores on either the Graduate Management Admissions Test or the aptitude test of the Graduate Record Examination. Please check with the department prior to enrolling for the test.
Degrees

MASTER OF BUSINESS ADMINISTRATION — 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, economics, and the behavioral sciences, as well as the knowledge of a specific management discipline. It is designed for those who wish to prepare for a career as a professor and who demonstrate a capacity for doing research that advances their field.

Candidates must have a bachelor's degree and proficiency in mathematics at a minimum background of Math. 125a-125b. Individual programs may vary to take advantage of differing backgrounds or to accommodate different special interests. All students must take core requirements comprised of two elements: a primary, theoretical core and a secondary, applied core. The primary core consists of the following 9 units: Econ. 501a or 511; 520; and M.A.P. 600. The secondary core consists of 9 units of research methodology courses selected with the consent of the student's adviser which develop research application skills in the student's major field.

In addition to the core, the program requires a major in one of the concentration fields available in the college: accounting, finance, organization behavior, operations management, management information systems, quantitative methods in business, and marketing. The minor may be chosen from any area other than the major field with the approval of the minor department or field.

BUSINESS AND CAREER EDUCATION

Professors Mark C. Smith, Acting Head, Richard A. Kidwell
Assistant Professor Sally N. Clark

The department offers programs leading to the Master of Education degree with majors in business education or distributive education. Technical and professional courses are offered for advanced degree programs for teachers of business and distributive education in secondary and postsecondary schools. Work is also provided for secondary, postsecondary, and vocational certification of graduate students in business and distributive education and for the planning and implementation of career education concepts in all fields. A minor in business education or in distributive education is available for doctoral students with majors in other disciplines.

All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research.

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

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as a result of the review.

471. Office Procedures and Problems (3) GC II Effective procedures in handling routine office duties; creativity in planning for innovation in the solution of office problems; emphasis on preparation for advancement to administrative positions.

472. Office Administration (3) GC I Analysis of functions of office departments, their organization and administration; development and use of office manuals, selection, training, and promotion of office employees; quality and quantity of office production.

474. Word Processing Concepts (3) GC II S Basic concepts of information/word processing with emphasis on proper utilization of people, procedures, and equipment.
482. Teaching Vocational Office and Distributive Education (3) GC I Development of vocational and career education; the organization and methods of teaching office and distributive education programs. (Identical with S.Ed. 482)

483. Development and Instruction of Adult Vocational Education Programs (3) GC I Organization, administration, promotion, curriculum construction, teaching methods, and evaluation of instruction in adult education programs. (Identical with S.Ed. 483)

484. Organization and Supervision of Vocational Education Programs (3) GC I The organization, administration, and supervision of vocational education programs, including a study of vocational curricula, funding, reporting, training, personnel, coordination, and evaluation, with primary emphasis on reimbursed vocational business education programs. (Identical with S.Ed. 484)

485. Cooperative Vocational Education Programs (3) GC II The role of the teacher-coordinator in the coordination, teaching, guidance, public relations, and administration of work-experience programs. (Identical with S.Ed. 485)

487. Microcomputers in Education (3) GC I S (Identical with Ed.F.A. 487)

488. Microcomputer Application (3) GC I S (Identical with Ed.F.A. 488)

497. Workshop h. Teaching Data Processing/Word Processing (3) [ Rpt./3] GC S

BUSINESS ECONOMICS
(See Economics)

CELLULAR AND DEVELOPMENTAL BIOLOGY
(See Molecular and Cellular Biology)

CHEMICAL ENGINEERING

Associate Professors William P. Cosart, Thomas W. Peterson, Farhang Shadman
Assistant Professors Heriberto Cabezas, Simon P. Hanson

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, bioprocessing 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 nontesis 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.

402. Intermediate Engineering Analysis (3) GC I Solution of complex chemical engineering problems utilizing both analytical and numerical techniques. P, Math. 254, Ch.E. 202, CR 204.
413. Process Control and Simulation (3) GC I Theory of automatic control as applied to elementary chemical engineering processes. Use of continuous system simulation languages for study of practical control problems in the process industries. P, CR 402.

418. Physiology for Engineers (4) GC II (Identical with Psio. 418)

419. Physiology Laboratory (2) GC II (Identical with Psio. 419)

421. Topics in Real-Time Computing (3) GC 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.


435. Corrosion (2) GC II (Identical with M.S.E. 435)

442. Chemical Engineering Design Principles (3) GC I Preliminary economic and design principles associated with chemical process equipment. P, 201, 203, 204, 304, 305; CR 430.

443. Chemical Engineering Plant Design (3) GC II Design project from scoping and process selection, through material and energy balances, equipment design and sizing, to economic analysis of capital cost and operating expense. P, 442.


461. Chemical Process Simulation (2) GC II Use of existing large, modular computer programs for computer-aided process design and analysis; program structure, convergence accelerators and control blocks. P, 442.

465. Current Problems in Energy and Power (1 to 4) Rpt./1 GC II (Identical with N.E.E. 465)


532. Solid-Fluid Reactions (3) I Characterization of solid structural properties; principles of heterogeneous reactions involving a fluid and a reacting solid. P, 306 and 430, or M.S.E. 450R and 412. (Identical with M.S.E. 532)

545. Combustion Generated Air Pollution (3) II (Identical with A.M.E. 545)


567. Advanced Solar Engineering (3) II (Identical with N.E.E. 567)

585. Advanced Biomechanics (3) II 1986-87 (Identical with A.M.E. 585)

589. **Energy Use: Analysis and Management** (3) I (identical with N.E.E. 569)


696. **Seminar**
   a. Chemical Engineering (1) [Rpt./6] II
   b. Combustion (1) [Rpt./6] II
   c. Kinetics (1) [Rpt./6] II
   d. Pollution Control (1) [Rpt./6] II
   e. Crystallization (1 to 3) [Rpt./6] II
   f. Extrusion (1) [Rpt./6] II
   g. Biomedical (1) [Rpt./6] II
   h. New Developments (1) [Rpt./6] II

**CHEMISTRY**


Associate Professors Neal R. Armstrong, Michael F. Burke, Dennis L. Lichtenberger, John V. Rund, G. Krishna Vemulapalli

Assistant Professors Peter E Bernath, William M. Hetherington, Eugene A. Mash, Jr., Jeanne E. Pemberton

The department offers programs leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees with a major in chemistry. Concentrations are available in analytical, inorganic, organic and polymer, and physical chemistry; and in biochemistry and several other interdisciplinary fields. The department also, in cooperation with the College of Education, offers work leading to the Master of Education degree with a major in chemistry. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog. Interested doctoral students may elect a concentration in chemical physics with a major in either chemistry or physics.

New students are assisted and advised by the departmental Graduate Study 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** — This program is designed for those who do not plan to be professional chemists or to work toward the Doctor of Philosophy degree. Students who plan to teach chemistry in secondary schools will find this program adapted to their needs.

Of the required fifteen units in the major subject, not more than five may (with the approval of the head of the department) be in a closely related field. At least six units, not including the thesis, must be in 500- or 600-level courses. A thesis is required but, at the
discretion of the head of the department, it need not embody the results of original labora-
tory research. In no case will more than four units be earned for the thesis and, if the course
work is divided between chemistry and another subject, not more than two units may be
earned for the thesis. If supporting work is not in a scientific discipline, no more than ten
units may be devoted thereto. All students must pass a final oral examination.

MASTER OF SCIENCE — A thesis based upon original laboratory research is required. All
students must pass a final oral examination.

DOCTOR OF PHILOSOPHY — The foreign language requirement must be met in a language
approved by the student's Dissertation Advisory Committee. Since teaching experience
strengthens an individual's grasp of principles, a year of teaching is generally required of
each student.

400a-400b. Chemical Measurements Laboratory (2-2) GC II Lab. work in modern chemical measure-
ments and instrumentation. 1R, 6L. 400a: P, 424 or CR; for majors, S.I.E. 170 or 272. 400b: P,
480b.

410. Inorganic Chemistry (3) GC I Fundamentals of inorganic chemistry. P, 480a or CR.

424. Instrumental Analysis (3) GC II Principles of modern instrumental methods of analysis treating
basic instrumentation and data acquisition, spectrochemical methods, mass spectrometry, gas
chromatography, and electroanalytical and thermal methods. P, 241b, 325 or 322, Phys. 102b or
103b, 180b.

440. Qualitative Organic Analysis (3) GC II 1985-86 The systematic classification and identification
of organic compounds. 1R, 6L. P, 241b, 243b or 245b, 325 or 322.

446. Organic Preparations (3) GC I 1986-87 Special experimental methods for the synthesis of
organic compounds. 1R, 6L. P, 241b, 243b or 245b.

460. General Biochemistry (5) GC I (Identical with Bioc. 460)

462a-462b. Biochemistry (4-3) GC (Identical with Bioc. 462a-462b)
**Credit is allowed for one course only in the following group: 460, 462a-462b.

480a-480b. Physical Chemistry (3-3) GC Fundamental principles of physical chemistry. P, 103b and
104b, or 105bH; Math. 125b; Phys. 102b or 103b or 116 or CR.

481. Biophysical Chemistry (3) GC II Topics in physical chemistry pertinent to the biological sci-
ences, including chemical dynamics, transport processes, thermodynamics, bonding, and spec-
troscopy, P, 480a.

501. Intermediate Analytical Chemistry (3) I Survey of principles of modern analytical chemistry. P,
480b.

241b.

503. Intermediate Physical Chemistry (3) I General survey of physical chemistry, including ther-
modynamics, structure, kinetics and electrochemistry. P, 480b.

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 1986-87 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.

520. Advanced Analytical Chemistry (3) I 1985-86 Statistical treatment of data, separation proc-
esses, kinetic and thermal methods of analysis. P, 480b.

521. Advanced Instrumental Analysis (2) 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 1986–87 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.


524. Chemical Instrumentation (4) I Data acquisition and experiment control by analysis and digital techniques; design of chemical instrumentation. 3R, 3L. P, 424.

525. Chemistry of Metal Chelates (3) I 1985-86 Theory underlying the application of chelating reagents in chemical analysis. P, 523.


530. Radiochemistry and Radiation Detection (3) I (Identical with N.E.E. 530)

540. Organic Syntheses (3) I Organic reactions and the methods by which they are applied to synthetic problems in organic chemistry. P, 241b, 480b.


561a-561b. Introduction to Biochemical Literature (1-1) (Identical with Bioc. 561a-561b)

565a-565b. Proteins, Enzymes and Physical Biochemistry (3-3) 1986-87 (Identical with Bioc. 565a-565b)

569. Structure and Function of Biological Membranes (3) II 1986-87 (Identical with Bioc. 569)

570. Molecular Biology of the Cell Membrane (3) I 1986-87 (Identical with Bioc. 570)

572. Metabolic and Hormonal Control of Cell Function (3) I 1986-87 (Identical with Bioc. 572)


586. Structural Thermodynamics (3) II Advanced concepts in both classical and modern thermodynamics, with particular emphasis on thermodynamics in solution. P, 480b.

587. 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.

588. Chemical Bonding and Structure (3) I An introduction to quantum mechanics, with applications to atomic structure and spectra, the nature of chemical bonding and molecular structure. P, 480b.

591. Coordination Chemistry (3) I 1985-86 Theory, structure, and chemistry of the group III, IV, and V elements. The chemistry of the hydrides, particularly of boron, are emphasized. Current theoretical approaches and experimental techniques are stressed. P, 510a.
680. Quantum Chemistry (3) II Principles of quantum mechanics with applications to the properties of molecules. P, 580.


696. Seminar
   a. Analytical Chemistry (1 to 3) I II
   b. Inorganic Chemistry (1 to 3) I II
   c. Organic Chemistry (1 to 3) I II
   d. Physical Chemistry and Chemical Physics (1 to 3) I II

CHILD DEVELOPMENT AND FAMILY RELATIONS
(See Family and Consumer Resources)

CHINESE
(See Oriental Studies)

CIVIL ENGINEERING AND ENGINEERING MECHANICS

Professors Paul H. King, Head, Reidar Bjorhovde, Carl J. Buckman (Emeritus), Dinshaw N. Contractor, Donald A. DaDeppo, Chandrakant S. Desai, David J. Hall (Emeritus), Simon Ince, Rudolf A. Jimenez, James D. Kriegh, Emmett M. Laursen (Emeritus), Allan J. Malvick, Haaren A. Miklofsky, Richmond C. Neff (Emeritus), Philip B. Newlin (Emeritus), Robert A. Phillips, Ralph M. Richard, Raymond A. Sierka, Terry Triffet

Associate Professors Gary L. Amy, Donald B. Hawes (Emeritus), Edward A. Nowatzki, Robert H. Wortman

Assistant Professors Curtis W. Bryant, Jay S. DeNatale, Mohammad R. Ehsani, Tribikram Kundu, James M. Witkowski

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 applied mechanics, engineering materials, regional development and urban planning, highway engineering, hydraulics and fluid dynamics, sanitary and environmental engineering, soil mechanics and soils engineering, surveying and mapping, water resources, structural engineering, and transportation. Certain interdisciplinary options are available; master’s degree students may select sanitary and environmental engineering or materials engineering, and doctoral students may select sanitary and environmental engineering. For further information concerning these options see Engineering elsewhere in this catalog.

Applicants should have completed an undergraduate major in civil engineering or engineering mechanics, but those with majors in the physical sciences or other engineering disciplines are also encouraged to apply, since such backgrounds provide excellent preparation for the approach to some areas of graduate work within the department.

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

In addition to the courses listed below, the Department of Civil Engineering and Engineering Mechanics faculty is prepared to offer temporary courses in the following areas, subject to faculty availability and student interest: public works planning and engineering, construction engineering, hydraulic engineering, sanitary and environmental engineering, structural engineering, soils engineering, transportation engineering, surveying and mapping, and urban planning and engineering.

Credit for these courses is offered in both civil engineering and engineering mechanics.


423. Hydrology (3) GC I Elementary treatment of major topics in hydrology, including rainfall, evaporation, groundwater, and runoff. Field trips. P, 321. (Identical with Hydr. 423)

424. Hydraulic Engineering Design (3) GC II Hydraulic criteria for design of bridges, stilling basins, gates, open-channel distribution and collection systems; sediment-transport effects; pipe networks and pumping systems. P, 322.

432a-432b. Advanced Structural Engineering Design (3-3) GC Advanced problems in the analysis and design of concrete, steel, and wood structures; yield line and plastic design methods, lateral and vertical load analysis of bridges and multistory buildings; introduction to seismic design; use of structural computer programs. 432a: P, 336. 432b: P, 337.

440. Foundation Engineering (3) GC II Site and subsurface investigations, design of footings and pile foundations; design of foundations on collapsing and swelling soils; computer methods. P, 340.

441. Stability in Soil Engineering (3) GC I Shear strength of soil; total vs. effective stress analysis; slope stability analysis methods including sliding block, circular and generalized surfaces; computer applications; earth pressure theories; flexible and rigid retaining structures; tunnels in soft ground; reinforced earth. P, 340.

452. Engineering Surveys (3) GC I Solar and Polaris observations; mineral, public, and private land surveys; route surveying, curves, and earthwork; triangulation, photogrammetry, and modern engineering surveys. 2R, 3L. P, 151.

454. Photogrammetry (3) GC II Reading, interpretations, and geometric characteristics of aerial photographs; stereoscopic principles and their application in the production of planimetric and topographic maps. 2R, 3L. P, 151, Math. 125a.

455. Surface irrigation (3) GC II (Identical with A.En. 455)

456. Boundary Surveys and Legal Principles (3) GC II Boundary control; property descriptions; public land surveys; writing and interpretation of deeds; subdivision standards; legal aspects; rights, duties and liabilities of land surveyors. Field trip.


463. Traffic Engineering (3) GC I Methods for the efficient and safe operation of transport facilities through analysis of capacity, safety, speed, parking, and volume data. P, 360.

464. Airport Planning and Design (3) GC II Location, analysis and design of airports and airport facilities, including aircraft characteristics, site selection, configuration, capacity, access and terminals. Field trips. P, 360.
465. Urban Systems Modeling (3) GC 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.

468. Urban Transportation Planning (3) GC 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 Ping. 468)

471. Water Quality Control (3) GC II Aspects of water quality maintenance; physical, chemical and biological factors in water and wastewater treatment and natural purification. 2R, 3L. Degree credit available for nonmajors only. P, Chem. 103b. (Identical with Hydr. 471 and Ws.M. 471)


479. Environmental Air Pollution (3) GC I Air pollution sources and pollutant control, with special consideration of the meteorological, urban, rural, industrial, and health aspects.

481. Construction Methods (3) GC II Introduction to estimating; construction planning and methods; selected topics of fundamental importance in construction, including the Critical Path Method and PERT. 2R, 3L. P, 336 or 337, 380 or CR.

486. Fundamentals of Industrial Hygiene (3) GC I (Identical with O.S.H. 486)

487. Advanced Industrial Hygiene and Safety (3) GC II (Identical with O.S.H. 487)

507. Drainage of Irrigated Lands (3) II (Identical with A.En. 507)


526. Water Quality Management (3) II (Identical with W.R.A. 526)

532. Advanced Strength of Materials (3) II Advanced problems in the analysis of deformable solids including curved beams, nonprismatic beams, torsion of thin-walled members, beam on elastic foundation, inelastic deformation.

536. Advanced Computer Graphics In Engineering (3) I (Identical with A.M.E. 536)

537. Prestressed Concrete Structures (3) II Behavior, analysis, and design of statically determinate and indeterminate prestressed concrete structures. P, 337.

544. Soil Stabilization (3) II Purpose of soil stabilization; stabilization using mechanical means, cement, asphalt, lime, salt and resin; factors governing stabilization techniques; special application. P, 340.

547. Seepage and Earth Dams (3) I Principles of flow in porous media; 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) I 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.

560. Ground-Water Management (3) II (Identical with W.R.A. 560)

561. Structural Design of Flexible Pavements (3) I Analysis of loads, stresses, material characteristics, and environmental factor for the theoretical and practical design, construction and maintenance of pavements. P, 340, 361.

562. Structural Design of Rigid Pavements (3) II Analysis of loads, stresses, material characteristics, and environmental factors for the theoretical and practical design, construction and maintenance of these pavements. P, 340, 361.

565. Quick Response Transportation Planning Methods (3) I 1985-86 Quick response transportation tools for subarea, problem and policy analysis, and strategic planning in the urban setting. (Identical with Ping. 565)

566. Highway Geometric Design (3) II 1986-87 Study of geometric elements of streets and highways, with emphasis on analysis and design for safety. P, 463.


574. Solid and Hazardous Waste Management (3) II Engineering, legal, planning, and management aspects of solid and hazardous wastes; overview of waste generation, collection, transport, processing, recovery, and disposal; emphasis on municipal wastes.

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.


596. Seminar
   a. Sanitary and Environmental Engineering (1 to 3) II
   b. Geomechanics/Mechanics (1) II (Identical with E.M. 596b)


621. Sediment Transportation (2) I 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.


623. Flow through Hydraulic Structures (3) II 1986-87 Subcritical and supercritical flow through culverts, bridges, spillways, stilling basins, transitions, bends; hydrologic effects on inflow; pumps and turbines. P, 322.

624. Planning and Design of Multipurpose Water Resources Projects (3) II 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.

637. Soil-Structure Interaction (3) I 1985-86 Explanation of soil-structure interaction, closed form and numerical solutions, beams, axially and laterally loaded piles and walls, wave equation for piles, group piles, slabs on deformable media. P, 640 or 641 or consult department before enrolling.

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.


642. Engineering Characteristics of Soil (3) II Advanced theories of mechanical and physical aspects of soil. Lab testing including index parameters, compaction, consolidation, shear strength; introduction to critical state and plasticity aspects. 1R, 6L. P, 640.


647. Seepage and Earth Dams (3) I Principles governing the flow of water through soils and their application in the design of earth dams; methods of earth dam design, including earthquake design; theory of wells and groundwater flow. P, 340.
648. **Constitutive Laws for Engineering Materials** (3) [Rpt./1] II 1985-86 Statement of axioms of continuum mechanics strain, stress and nonlinear behavior. Laboratory testing including hyperelasticity, hypoelasticity, rate type models, plasticity review, hardening, volume change and dilatancy, softening, inherent and induced anisotropy, laboratory testing and implementation. P, E.M. 505, E.M. 603, or consult department before enrolling. (Identical with E.M. 648)


671. **Advanced Water and Wastewater Analysis** (3) II Advanced chemical, physical and microbiological analyses as related to water and wastewater quality and advanced treatment process design. 1R, 6L. P, 371.


673. **Advances in Water and Waste Reclamation and Reuse** (3) II Theory, application, and evaluation of currently developing techniques in water and waste reclamation and reuse. P, 675.

675. **Wastewater Treatment** (3) I Administration, financing, design, construction, and operation of wastewater disposal systems. P, 371.


**Engineering Mechanics**

In addition to the courses listed below, the Department of Civil Engineering and Engineering Mechanics faculty is prepared to offer temporary courses in the following areas, subject to faculty availability and student interest: public works planning and engineering, construction engineering, hydraulic engineering, sanitary and environmental engineering, structural engineering, soils engineering, transportation engineering, surveying and mapping, and urban planning and engineering.

Credit for these courses is offered in both civil engineering and engineering mechanics.

402. **Introduction to Finite Element Methods** (3) GC I II (Identical with C.E. 402)

505. **Continuum Mechanics** (4) I Analysis of deformation, principal stresses and strains, velocity fields, and rate of deformation; constitutive and field equations; elementary elasticity.

539. **Advanced Structural Mechanics** (3) II (Identical with A.M.E. 539)

596. **Seminar**

b. Geomechanics/Mechanics (1) II. (Identical with C.E. 596, which is home.)

603. **Elasticity Theory and Application** (3) I General three-dimensional equations of elasticity; problems in plane stress, plane strain, extension, torsion; energy and residual (Galerkin) methods; applications to rings, beams, plates, torsion and other problems. P, C.E. 217, 302 or S.I.E. 270.

604. **Plasticity Theory and Application** (3) II Yield conditions and flow rules for perfectly plastic and strain hardening materials; application to various elastoplastic problems such as bars, cylinders and plates; effect of volume change behavior, isotropic and anisotropic hardening plasticity with expanding/contracting yield surfaces.


635. **Matrix Methods in Structural Mechanics** (3) I Formulation of the force and displacement methods; the finite element method, with application to bar, beam, plate, and shell structures; organization and development of computer programs; linear and nonlinear systems. P, C.E. 331 or A.M.E. 436.

637. **Plates and Shells** (3) I Theory and analysis of circular, rectangular and continuous plates by classical, numerical and approximate methods; introduction to in-plane forces and shells. P, C.E. 336 or A.M.E. 434.


648. **Constitutive Laws for Engineering Materials** (3) [Rpt./1] II (Identical with C.E. 648)
CLASSICS

Professors David Soren, Head, Norman Austin, Garnet D. Percy (Emeritus)
Associate Professors Richard C. Jensen, Jon D. Solomon, Thomas D. Worthen

The department offers a degree of Master of Arts with a major in classics with concentrations in classics (Greek/Latin) or classical archaeology. The graduate courses are open to all graduate students in the University with the permission of the instructor, with the exception of 510, 553, and 599 which are open only to students admitted to the Master of Arts degree program in Classics.

401. Latin Reading Course (3) [ Rpt. ] GC I II Extensive readings in one of the following: epic, lyric, drama, history, oratory, satire, epistles, novel, philosophical, technical or medieval literature. P, 201b.

402. Greek Reading Course (3) [ Rpt. ] GC I II Extensive readings in major Greek authors including Homer, Plato, and the historians and dramatists. P, 202b.

403a-403b. History of Greece (3-3) GC (Identical with Hist. 403a-403b )

404a-404b. History of Rome (3-3) GC (Identical with Hist. 404a-404b )

409. Greek Composition (3) GC II Analysis of Greek prose style and practice in composing Greek prose. P, 102, 202 or consult department before enrolling.

410. Latin Composition (3) GC I Analysis of Latin prose style, review of Latin grammar, practice in composing Latin prose. P, 101 and 201 or consult department before enrolling.

411. Roman Art and Architecture (3) GC (Identical with Art. 411 )

412. Topics in Greek Philosophy (3) [ Rpt./1 ] GC Extensive readings in Greek in one of the following areas of Greek philosophy: the pre-Socratics, Plato's ethics and epistemology, Aristotle's Nicomachean Ethics.

413. Augustan Literature (3) GC II Survey of the major writers of the Augustan Age, the period from about 30 B.C. to 14 A.D., with the exception of the Elegiac poets. P, 101 or 201 or consult department before enrolling.

414. Medieval Latin (3) GC Survey of Latin literature during the thousand years between the end of the classical period and the beginning of the Renaissance. P, 101 and 201 or consult department before enrolling.

415. Latin Love Elegy (3) GC Intensive reading of selections from Ovid, Tibullus and Propertius.

417a-417b. Sanskrit Grammar and Texts (3-3) GC 1986-87 (Identical with Or.S. 417a-417b )

443. The Archaeology of Neolithic and Bronze Age Greece (3) GC History, art and culture of Neolithic and Bronze Age Greece through the study of archaeological excavations. P, six units or CR in clas., hist. or anth. (Identical with Anth. 443 )

454. Greek and Roman Sculpture (3) GC A survey of the development of classical sculpture from the eighth century B.C. to circa 300 A.D. P, 240a-240b.

456. Greek and Roman Painting (3) GC 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, 240a-240b

457. Greek Architecture (3) GC 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, 240a-240b

470. Greek Philosophy (3) GC [ Rpt. ] (Identical with Phil. 470 )

488. History of Byzantium (3) GC II (Identical with Hist. 488 )


511. Greek Lyric Poetry (3) Intensive study in Greek of the early Greek Lyric writers from Archilochus to Bacchylides, including Pindar. P, 102 and 202 or consult department before enrolling.
512. **Topics in Greek Drama (3)** Close Reading in Greek of either (1) tragedy - 1 play each by Aeschylus, Sophocles and Euripides or (2) comedy - 2 plays of Aristophanes, 1 of Menander. P, 102 and 202 or consult department before enrolling.

513. **Roman Drama (3)** Representative plays of Plautus, Terence and Seneca, read in Latin. P, 101 and 201 or consult department before enrolling.

514. **Home (3)** Close reading of selections from the *Iliad* and *Odyssey* in Greek and an introduction to the critical secondary literature. P, 102 and 202 or consult department before enrolling.

515. **Cicero (3)** The life of Cicero illustrated by means of close reading of selected works in Latin (*pro Caelio*, selections from the *Philippics*, the *Verrine Orations*) as well as selections from his letters. P, 101 and 201 or consult department before enrolling.

553. **Introduction to Graduate Study in Classical Archaeology (3)** An historiographic survey of classical archaeology with discussion of Heinrich Schliemann, Luigi Palma de Cesnola, Charles Folli Mckim and others. P, 240a or 240b.

554. **Topics in Greek and Roman Architecture and Urbanism (3)** Research papers on an aspect of ancient architecture which involves not only monuments themselves but attempts to consider a building in its physical and cultural setting. P, 240a or 240b.

555. **Topics in Greek and Roman Archaeology (3)** Research papers and oral presentations on different aspects of Greek and Roman archaeology; preparation in writing scholarly articles for refereed journals. P, 240a or 240b.

556. **Greek and Roman Provincial Archaeology (3)** Survey of classical archaeology in ancient Tunisia, Cyprus, Portugal and Turkey. P, 240a or 240b.

595. **Colloquium**
   f. **Advanced Studies in Ancient History (3)** II (Identical with Hist. 595f, which is home)

596 **Seminar**
   a. Ancient Greek Literature (3) Open to graduate majors only.
   b. Latin Literature (3) Open to graduate majors only.
   c. Aegean, Roman and Mediterranean Provincial Archaeology (3) Open to graduate majors only.

**CLINICAL ENGINEERING**
*(See Engineering)*

**CLOTHING, TEXTILES AND INTERIOR DESIGN**
*(See Family and Consumer Resources)*

**COMPOSITION**
*(See Music)*

**COMPUTER ENGINEERING**
*(See Electrical and Computer Engineering)*

**COMPUTER SCIENCE**

Professors David R. Hanson, *Head*, Ralph E. Griswold, Webb C. Miller
Associate Professors Gregory R. Andrews, Peter J. Downey, Christopher W. Fraser
Assistant Professors Timothy A. Budd, Eugene W. Myers, Richard D. Schlichting

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. Areas of research interest within the department currently include programming languages, operating systems, distributed processing, analysis of algorithms, software engineering and numerical software.
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 on the aptitude test of the Graduate Record Examination. The department recommends, but does not require, that two letters of recommendation be submitted.

A brochure describing admissions requirements and degree programs in detail is available from the Department of Computer Science.

**Degrees**

**MASTER OF SCIENCE** — This program is designed to provide the student with a broad background in computer science. Thirty units of graduate credit are required, including certain specified core courses. A thesis is not required; with departmental approval a student may elect to submit a thesis.

**DOCTOR OF PHILOSOPHY** — Doctoral students must complete the requirements for the master's degree, as well as additional courses determined by the department. Course 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.

402. Mathematical Logic (3) GC II 1985-86 (Identical with Math. 402)
422. Mathematical Programming and Applications (3) GC (Identical with M.I.S. 422)
430. Software Tools (3) GC I II Techniques for the design and implementation of programs that assist in programming: filters; file managers; editors; text processors. P, 327, 342.
440. Numerical Software (3) GC II Floating-point arithmetic; design and analysis of numerical algorithms; implementation issues; testing and performance measurement; software tools. P, a programming and a linear algebra course.
443. Theory of Graphs and Networks (3) GC II 1985-86 (Identical with Math. 443)
452. Principles of Operating Systems (3) GC II Concepts of modern operating systems; concurrent processes; process synchronization and communication; resource allocation; kernels; deadlock; memory management; file systems; protection mechanisms. P, 237, CR 430.
453. Translators and Systems Software (3) GC I Design and implementation of translation-oriented systems programs: macroprocessors; preprocessors; assemblers; loaders; linkers; introduction to compilers and operating systems. P, 237, 430.
472. Continuous-System Simulation (3) GC I (Identical with E.C.E. 472)
473. Theory of Computation (3) GC I II Mathematical preliminaries; finite automata, regular expressions, applications; context-free grammars, pushdown automata, Turing machines, undecidability. P, knowledge of a programming language; Math. 243 or 215. (Identical with Math. 473)
474. Digital Logic Design (3) GC I II (Identical with E.C.E. 474)
475a-475b. Mathematical Principles of Numerical Analysis (3-3) GC (Identical with Math. 475a-475b)
476. Computer Architecture (3) GC I II Functional overview of computer systems; interconnection of basic components; input/output; interrupts; virtual addressing; stack architecture; microprogramming; microprocessors. P, 237. (Identical with E.C.E. 476)
478. Computational Methods of Algebra (3) GC II (Identical with Math. 478)
479. Game Theory and Mathematical Programming (3) GC II 1985-86 (Identical with Math. 479)
520. Principles of Programming Languages (3) II Global semantics of algorithmic languages, including scope of declarations, data types, retention, block structure, binding time, subroutines, coroutines, extensibility; implementation issues. P, 430.
521a-521b. Advanced Systems Modeling and Simulation (3-3) (Identical with M.I.S. 521a-521b)
541a-541b. Computer-Aided Information Systems Analysis and Design (3-3) (Identical with M.I.S. 541a-541b)
545. **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, 342, 473, Math. 362.

550. **String and List Processing** (3) I Data representation, pattern matching, structures; applications in symbolic mathematics, text analysis, document formatting, cryptography, etc. P, 327, 342.

552. **Principles of Parallel Programming** (3) I Fundamental concepts and applications of parallel programs; program verification; synchronization mechanisms in programming languages; distributed processing concepts; case studies of languages; access control and information flow. P, 452.

555. **Principles of Compilation** (3) II Finite automata and lexical analysis; context-free grammars; parsers; parser generators; code generation; graph-theoretic approaches to optimization. P, 453, 473.

560. **Formal Language Theory** (3) II Basic concepts of languages and their representations; types of grammars and their relation to programming languages and automata; ambiguity and decidability questions for languages. P, 473.

571. **Digital Systems Design** (3) I (Identical with E.C.E. 571)

573. **Microprocessors, Minicomputers and Real-Time Distributed Processing** (3) II (Identical with E.C.E. 573)

575a-575b. **Numerical Analysis** (3-3) (Identical with Math. 575a-575b)

620. **Advanced Topics in Programming Languages** (1 to 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** (1 to 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** (1 to 3) [Rpt./12 units] II Design and analysis of algorithms; specific topics to be determined by current literature and faculty and student interest.

652. **Advanced Topics in Operating Systems** (1 to 3) [Rpt./12 units] II Operating system design, development, analysis, and performance; specific topics to be determined by current literature and faculty and student interest.

660. **Advanced Topics in Theory of Computation** (1 to 3) [Rpt./12 units] I Specific topics to be determined by current literature and faculty and student interest.

674. **Sequential Circuits and Automata** (3) I (Identical with E.C.E. 674)

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**CONDUCTING**

(See **Music**)

**CONSUMER STUDIES**

(See **Family and Consumer Resources**)

**CORRECTIONAL ADMINISTRATION**

(See **Management and Policy**)

**COUNSELING AND GUIDANCE**

Professors O. C. Christensen, Roger J. Daldrup, Bill W. Hillman  
Associate Professors Richard L. Erickson, Head, Harley D. Christiansen, Philip J. Lauver, Elizabeth B. Yost  
Assistant Professor Betty J. Newlon

The department offers programs leading to the Master of Arts, Master of Education, Doctor of Philosophy, and Doctor of Education degrees with a major in counseling and guidance. Concentrations are available in elementary and secondary school counseling,
138 DEPARTMENTS AND COURSES OF INSTRUCTION

classroom guidance, career counseling, student personnel work in higher education, marriage, family, and agency counseling. A minor program of fifteen units minimum is available for doctoral students majoring in other fields.

Forms and statements regarding application procedures for master's and doctoral programs are obtainable on request from the department. Master's degree applicants must submit a personal data blank, a candidate's statement and letters of recommendation to the department. The usual requirement of 15 units of undergraduate credit in education may be waived for master's students electing to concentrate in career counseling, student personnel work in higher education, marriage, family, and agency counseling where evidence of other appropriate course work or experience is presented. Doctoral applicants must hold a master's degree in counseling and guidance or in an equivalent program and submit, to the Office of Graduate Study in Education, personal data blank, letters of recommendation, and scores of the Graduate Record Examination. Doctoral applicants must also have completed, before admission, a minimum of one year of successful, full-time, post-master's, professional experience in the proposed area of concentration. All application material for fall admission must be received by March 1 and by October 1 for spring admission.

Individual master's programs will be planned with and approved by an adviser. These may vary both in course work and in total units, depending upon the area of concentration and upon past experience and training. Because of course sequencing and practicum requirements, master's students should plan on devoting a minimum of three academic semesters or one academic year and two summer sessions to complete degree requirements. Recommended or typical programs may be obtained on request from the department. A thesis is required for the Master of Arts degree. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. For information concerning the Master of Education degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog. Doctoral programs are individualized after consideration of professional goals and past experience and training. An outside minor is required. Doctoral candidates must complete Ed.P. 640.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which have been made as a result of the review.

401. Basic Skills in Counseling (3) GC I Selected counseling skills and their applications to non-counseling settings. Designed for nonmajors needing basic skills in counseling as an adjunct to other primary occupational functions.

403. Principles of Adlerian Psychology (3) GC I II Techniques for the study of human behavior; implications for improving adult-child relationships, with emphasis on Adlerian principles.

445. Nonpharmacological Issues of Medicines (3) GC I (Identical with Ph.Pr. 445)

489. Clinical Pharmacotherapy of Mental Disorders (3) GC I (Identical with Ph.Pr. 489)

521. Techniques of interviewing (3) GC I II Types and functions, process, and application of the interview in various settings.

531. Career Education (3) I Concepts and goals, elements and systems of career education, with emphasis on development of materials and teaching strategies for implementing objectives in the elementary and secondary classroom. Open to nonmajors. (Identical with Elem. 531 and S.Ed. 531)

549. Counseling and Guidance Laboratory (1 to 3) [ Rpt. ] I II Supervised observation and participation in selected counseling and guidance activities: campus, public school, and community settings.

557. Methods in Marital Therapy (3) II 1986-87 (Identical with C.D.F.R. 557)

567. Law for Teachers and Student Personnel Workers (3) II (Identical with Ed.F.A. 567)

570. Counseling the Adult (3) I Adult crisis, midlife changes and developmental patterns; counseling techniques and intervention strategies.

571. Counseling Women (3) II Examination of the counseling needs of contemporary women and current types of intervention designed to meet these needs. (Identical with W.S. 571)
581. Human Relations Training (3) GC I II Interdisciplinary human relations training lab. for assessment and development of communication and interpersonal skills. Applications in the home, business, educational and community settings. (Identical with Ed.F.A. 581)

597. Workshop
   b. Classroom Group Guidance (3) I S
   c. Self-Management Techniques (3) S
   j. Anger, Depression and Guilt (3) S
   k. Family Systems and Psychodrama (3) S.

601. Foundations of Counseling (3) I II 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 lab. experience in selected settings. Open to majors only.

602. Foundations of Student Personnel Work in Higher Education (3) I (Identical with H.Ed. 602)

607. The College Student (3) I (Identical with H.Ed. 607)

617. Student Personnel Services in Higher Education (3) II (Identical with H.Ed. 617)

622. Appraisal of the Individual (3) I II Methods of appraising and reporting individual behavior, with emphasis on nonpsychometric data. Open to majors only.

623. Testing in Counseling (3) I II Evaluation and selection of psychological tests for guidance; use of psychometric data in counseling. Open to majors only.

631. Career Counseling (3) I II Theories of vocational development; types, sources, and use of occupational and educational information in career counseling and decision making. P, 601 or CR.


644. The Counseling Process (3) I 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 II Contemporary issues, concepts, and procedures in premarriage and marriage counseling. P, 581, 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; lab. experience. P, 403.


682. Group Techniques (3) I II Group techniques and underlying theories; applications in schools and agencies; interrelationship of group and individual approaches in counseling and related programs. P, 622, 601 or CR.

683. Group Counseling (3) I Theory and process in group counseling; applications in school, college, and community settings; lab. experience. P, 644.

693. Internship
   a. Counseling (1 to 9) [ Rpt. ] I II
   b. Student Personnel Services (1 to 9) [ Rpt. ] I II
   c. Career Guidance (1 to 9) [ Rpt. ] I II

694. Practicum
   P. 24 units of counseling courses. Supervised practice is offered on the basis of need and demand in the following areas:
   a. Elementary School Counseling (1 to 9) [ Rpt. ] I II
   b. Secondary School Counseling (1 to 9) [ Rpt. ] I II
   c. Higher Education Counseling (1 to 9) [ Rpt. ] I II
   d. Agency Counseling (1 to 9) [ Rpt. ] I II
   e. Family Counseling (1 to 9) [ Rpt. ] I II
   f. Group Counseling (1 to 9) [ Rpt. ] I II
   g. Marriage Counseling (1 to 9) [ Rpt. ] I II
   h. Career Counseling (1 to 9) [ Rpt. ] I II
DEPARTMENTS AND COURSES OF INSTRUCTION

140
coloquium
b. Professional Practice (1 to 3) [ Rpt.] III
c. Counselor Education and Supervision (1 to 3) [ Rpt.] III
d. Counseling Theory (Theory varies) (1 to 3) [ Rpt.] III
f. Career Development (1 to 3) III

CREATIVE WRITING
(See English)

CRIMINAL JUSTICE ADMINISTRATION
(See Management and Policy)

DAIRY SCIENCE
(See Animal Sciences)

DANCE

Committee on Dance

Professor John M. Wilson
Associate Professors Isa Bergsohn, Chairperson, Nina Janik
Assistant Professor Mary K. Wolff

The Committee on Dance offers a dance concentration within a drama major, Master of Arts degree, in cooperation with the Drama Department. Interested students should consult the Committee on Dance.

445. Advanced Choreography (2) I GC Movement qualities, motif development, and geometric principles applied to group composition. 4S. P, 245b.

496. Proseminar
   d. Dance-Related Art Forms (1 to 3) GC II 1986-87 (Identical with Dram. 496d) Bergsohn.

540a-540b. Advanced Ballet (2-2) [ Rpt./1] P, 440a-440b.

541a-541b. Professional Level Modern Dance Technique (2-2) [ Rpt./1] P, 441a-441b.

545. Literary Resources for Choreography (3) II 1986-87 Studies in primary world literature, in drama, and in psychology of personages as sources for choreographic themes; presentation of motifs and scenario. 6S. P, 445 or 594 Wilson. (Identical with Dram. 545)

697. Workshop
   a. Concert Production and Choreography (2 to 4) [ Rpt./4 units] III 4-8S. P, 445, 594.

DIETETICS
(See Nutrition and Food Science)

DISTRIBUTIVE EDUCATION
(See Business and Career Education)

DRAMA

Professors Robert C. Burroughs, Head, Irene F. Comer (Emerita), J. Michael Gillette, Robert A. Keyworth (Emeritus), Peter R. Marroney (Emeritus)
Associate Professors Harold W. Dixon, Rosemary Gipson, Peggy Kellner, William A. Lang, Peter Lehman, Jeffrey L. Warburton
Assistant Professors Richard T. Hanson, Dianne J. Winslow
The department offers programs leading to the Master of Arts and the Master of Fine Arts degrees with a major in drama. For further details concerning these programs see Requirements for Master's Degrees/Master of Fine Arts elsewhere in this catalog.

Students working toward the Master of Arts degree are required to complete 600, and 12 units selected from 640, 641, 642a-642b, and 644. Each student must present a thesis or pass a comprehensive written examination. The proposed study program of each student must be approved by the department.

In cooperation with the Department of Drama, the Committee on Dance offers a program of advanced study which leads to a Master of Arts in drama with a dance concentration. For a listing of graduate courses, see Dance.

404. Musical Theatre III (3) GC II Intensive scene study and exploration of the major historical styles and genres of the American musical theatre. 2R, 2S. Open to majors only. P, 304 and audition.

410. Creative Drama (3) GC I Principles and procedures of improvisation, role-playing, creative playwriting techniques, and program development in creative dramas applicable to the elementary and secondary school levels. P, twelve units of dram. or education.

412. Theatre for Children (3) GC II Principles and techniques of selecting plays, playwriting, directing, designing and producing theatre for children. 2R, 3L. P, twelve units of dram. or education.


416. Theatre Graphics III (2) GC II Advanced practical color theory in pigment and light, scenographic rendering mediums and techniques. P, 120.


421. Lighting and Sound Technology (3) GC II Applied theory and techniques associated with sound system and visual effects in the theatre. 2R, 3L.

423. Scené Painting (3) GC I Techniques and methods of scenic painting.


425. Advanced Stagecraft (3) GC I Advanced studies in scenic construction methods and techniques. P, 111.

427. Advanced Stage Costume Construction (3) GC II Advanced techniques in costume construction, including period pattern design, cutting and draping techniques. P, 116.


430. Stage Management (2) GC I Principles and techniques of stage management, practical applications, problems and analysis of stage managing. P, 111, 151.

431. Theatre Publicity and Box Office (2) GC I Publicity, press releases, sales, advertising, display techniques, subscription procedures. P, twelve units of drama.

432. Theatre Management (2) GC II Amateur, educational and professional theatre organization and management; theatrical contracts, professional unions and representative organizations. P, twelve units of drama.

436. Shakespeare through Performance (3) GC I (Identical with Sp.C. 436)

440a-440b. History of the Modern Theatre (3-3) GC Major developments in theatrical art from 19th-century realism to the theatre of the present.

449. Acting V (3) GC I Intensive study of classical acting styles with emphasis on Shakespeare. Individual and group performance. 2R, 2S. P, 251 and audition.


452. Acting VII (3) GC I [ Rpt./1] Audition material, techniques and research into problems of a professional career in the theatre, television, motion pictures and related fields. 2R, 2S. P, 305, 449.

455. Directing I (3) GC I Basic techniques of stage directing including play analysis, director-actor communication and technical problems of movement, composition, picturization and blocking. 2R, 2S.

456. Directing II (3) GC II Techniques of stage direction with the study of factors leading to a completed production; special attention given to director-designer communication and the production process. Direction of one-act plays. 2R, 2S. P. 455.

460a-460b. Writing for Stage and Screen I (2-2) GC Preparation and analysis of brief scripts for stage and motion pictures; staged readings and lab. productions.

475. Screen Acting Techniques (3) GC II Principles and techniques of various performance methods involved in acting for television and 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. (Identical with R.T.V. 475)

496. Proseminar
   a. Portfolio (1 to 2) GC I II
   b. Cinema Production and Practices (1) GC II
   c. Advanced Topics in Film Studies (3) [Rpt./3] GC I II P, 109 or consult department before enrolling.
   d. Dance Related Art Forms (2 to 3) GC II (Identical with Dnc. 496d, which is home).

497. Workshop
   a. Technical Production (1 to 6) [Rpt./20 units] GC I II S
   b. Costume Production (1 to 6) [Rpt./20 units] GC I II S
   c. Lighting/Sound (1 to 6) [Rpt./20 units] GC II S
   d. Production Design (1 to 6) [Rpt./20 units] GC II S
   e. Scenic Design (1 to 6) [Rpt./20 units] GC II S
   f. Performance (1 to 6) [Rpt./20 units] GC II S
   g. Cinema Production (1 to 6) [Rpt./20 units] GC I II S

545. Literary Resources for Choreography (3) II 1986-87 (Identical with Dnc. 545)

560a-560b. Writing for Stage and Screen II (3-3) Preparation and analysis of full-length scripts for stage and motion pictures. Production possible for selected scripts.

600. Introduction to Graduate Study of Drama (2) I Methods and materials for research in theatre and drama; introduction to the bibliography of these fields; organization and form of thesis.

605. Advanced Voice and Movement for the Actor I (4) [Rpt./1] I Advanced study and exercise in voice and movement for the actor: relaxation, breathing, physical and vocal freedom, resonance, articulation and improvisation including the Linklater Approach, I.P.A., and Neutral Mask. 2R, 4S.

606. Advanced Voice and Movement for the Actor II (4) [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. 2R, 4S. P, 605.

640. 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.

641. 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.

642a-642b. Studies In Theatre History (3-3) Concentrated study in theatre history, with major emphasis on the physical theatre, standard scholarly works, and source materials. 642a: Beginnings to circa 1660. 642b: Circa 1660 to 1975. 642a is not prerequisite to 642b.

644. History of the American Theatre (3) II Studies in the American theatre and drama. Directed and individual projects will be assigned.


651. Experimental Theatre II (3) II Theories and techniques of avant-garde theatre. Rehearsal and performance of select projects.

655. Advanced Directing I (3) I 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 the staging of Shakespeare. 2R, 2S. P, 456.
656. **Advanced Directing II** (3) I, 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 Molière, the English Restoration, and similar historical texts. 2R, 2S, P, 655.

**Seminar**

a. Contemporary Trends (1 to 3) I, II
b. Special Topics in Acting (1 to 3) I, II
c. Special Topics in Directing (1 to 3) I, II
d. Musical Theatre Production (1 to 3) I, II
e. Directing the Full-Length Motion Picture (1 to 3) I, II
f. Film Editing (1 to 3) I, II
g. Documentary and Educational Films (1 to 3) I, II
h. Theatrical Design (1 to 3) [Rpt./3 units] I
i. Period Design Style (1 to 3) II  

**EARLY CHILDHOOD EDUCATION**

(See Elementary Education; Family and Consumer Resources)

**ECOLOGY AND EVOLUTIONARY BIOLOGY**


Associate Professors Russell Davis, Robert S. Mellor, Richard E. Michod, Stephen M. Russell, Oscar G. Ward

Assistant Professors Astrid Kodric-Brown, D. Lawrence Venable, David J. A. Vleck

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in ecology and evolutionary biology and in botany. Concentrations are available in botany; environmental physiology; evolution; genetics; marine biology; population and community ecology; and vertebrate biology and systematics. 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, and the Research Ranch, Elgin, Arizona.

Applicants are required to furnish the department with completed departmental application forms, scores on the Aptitude and Advanced (any discipline) tests of the Graduate Record Examination, transcripts of all college work (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. Applicants are encouraged to seek external financial support from institutions such as the National Science Foundation and the Danforth Foundation. The department will make every effort to offer financial aid to matriculating students in the form of teaching or research assistantships.

Course work, while necessary for acquiring needed information and skills, is no substitute for scholarship. Accordingly, 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.

401. **Biological Materials** (2) GC I Study of new methods in instruction and ideas on course content and behavioral objectives. Designed for prospective bio. teachers in secondary schools. 1R, 3L, P; twelve units of bio.

402. **History of Biology** (3) GC II (Identical with Hist. 402)
144  DEPARTMENTS AND COURSES OF INSTRUCTION

403R. Biology of Animal Parasites (3) GC I (Identical with V.Sc. 403R)

412. Plants Useful to Man (2) GC 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.

413. The Plant Kingdom (3) GC S Designed for public school teachers and others wishing to become familiar with the major plant groups in our environment; collecting and growing plants. Field trip.

414. Plants of the Desert (2) GC S Designed for teachers and others wishing to become familiar with common native and cultivated plants; identification, ecology, and uses.

418a-418b. Scientific Illustration-Photography (2 to 4 - 2 to 4) [ Rpt. ] GC Individual basic training in the execution of thesis drawings and graphic art techniques. Consult dept. before enrolling. (Identical with Anth. 418a-418b)

421. Philosophy of the Biological Sciences (3) GC I 1985-86 (Identical with Phil. 421)

428R. Advanced Microbial Genetics (3) GC II (Identical with M.C.B. 428R)

428L. Advanced Microbial Genetics Laboratory (2) GC I (Identical with M.C.B. 428L)

431. Environmental Physiology (3) GC II 1985-86 Analysis and synthesis of recent studies of the physiological responses of animals to their environments. P, 468R.

433. Advanced Scientific Illustration (4) [ Rpt./1] GC S Individualized advanced work in scientific illustration; lecture demonstrations on a variety of techniques. Field trips. P, 418a. (Identical with Anth. 433)


435. Evolution (3) GC 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, 102, 320; Math. 125a, CR Math. 125b.

436. Plant Ecology (4) GC II Dynamic processes giving rise to ecological patterns in plant populations and communities. 2R, 6L. Field trips. P, 102 and a basic botany course.

437. Floras of North America (2) GC II Analysis of the ranges of naturally-occurring plant taxa and communities of North America, both past and present. Two-day field trip.

438. Biogeography (3) GC II The role of historical events and ecological processes in determining the past and present geographic distribution of plants and animals. P, 102 or Geos. 225. (Identical with Geos. 438)

440R. Oceanography (2) GC II Introduction to the physical, chemical, geological, and biological dimensions of the oceans, with emphasis on their importance as biological environments. P, six units of a physical sci.

440L. Oceanography Laboratory (2) GC II Field and lab. investigations of the Gulf of California, with emphasis on research techniques important to biological oceanography. Weekend field trips. P, 440R or CR.

441. Limnology (4) GC I (Identical with W.F.Sc. 441)

442. Marine Ecology (6) GC 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. Consult instructor before enrolling.

450. Developmental Plant Anatomy (4) GC II 1986-87 Origin, development, and maturation of vascular plants. 3R, 3L. P, 101b or 104.

458. Comparative Vertebrate Anatomy (4) GC I (Identical with V.Sc. 458)

459. Comparative Vertebrate Histology (4) GC II (Identical with V.Sc. 459)

460. Plant Physiology (4) GC II (Identical with M.C.B. 460)

464aR-464bR. Human Physiology (3-3) GC Basic principles and concepts of physiology applied to humans. P, 104 or 159b; Chem. 241b, 243b. (Identical with M.C.B. 464aR-464bR and Tox. 464aR-464bR)

ECOLOGY AND EVOLUTIONARY BIOLOGY

468R. Comparative Physiology (3) GC I The responses of physiological systems to the environment; energy exchanges, respiration, thermal and osmotic regulation, locomotion, behavioral regulation, and integration of responses. P, 102, 104.

468L. Comparative Physiology Laboratory (1) GC I Physiological measurement techniques in laboratory and field studies. P, CR 468R.

470. Plant Diversity and Evolution (3) GC I Survey of the plant kingdom, with emphasis on comparative structure and evolution of major plant divisions. 2R, 3L. Field trips. P, four units of bio. or pl.s.

472. Systematic Botany (4) GC II Evolutionary relationships of orders and families of spermatophytes; systems of classification; collection and identification of local flora. 2R, 6L.

473. Legumes, Grasses, and Composites (2) GC I 1986-87 Identification and classification of the three largest flowering plant families of the Southwest. 6L.

475. Freshwater Algae (3) GC II 1985-86 Systematics, ecology, and evolution of planktonic and benthic species; field techniques and lab. culture. 2R, 3L. Field trips. P, four units of bio. or pl.s.

476. Marine Algae (4) GC II 1986-87 Systematics, ecology, and evolution of marine algae; field collection in marine environments and lab. culture. 2R, 6L. Field trips. P, four units of bio. or pl.s.

477. Aquatic Plants (3) GC I Identification, ecology and economic importance of freshwater aquatic plants, as related to fisheries, wildlife management, limnology, plant ecology and aquatic biology. 2R, 3L. Field trips. P, four units of bio. or pl.s.

480. Invertebrate Zoology (4) GC I Comparative morphology, physiology, and ecology of invertebrates. 2R, 6L. Field trips. P, 104.

482. Ichthyology (4) GC I Ecology, evolution and systematics of fishes, with field and lab. emphasis on Gulf of California and Arizona fishes. 2R, 6L. Weekend field trips. P, 104. (Identical with W.F.Sc. 482)

483. Herpetology (4) GC II Systematics, ecology, and evolution of the amphibians and reptiles. 2R, 6L or field work. P, 104.

484. Ornithology (4) GC II Natural history of birds and its bearing upon the problems of animal behavior, distribution, and evolution. 2R, 2L. Field trips. P, 104. (Identical with W.F.Sc. 484)

485. Mammalogy (4) GC I Systematics, ecology, and evolution of mammals. 2R, 6L or field work. P, 104. (Identical with W.F.Sc. 485)

487. Animal Behavior (3) GC I Concepts and principles of the evolution, development, causation and function of behavior, with emphasis on the adaptiveness of behavior; discussion and films. P, eight units of bio.

488. Sociobiology (2) [Rpt.] GC I Selected topics in animal behavior; survey of recent literature, with emphasis on sociobiological theory. P, 487 or CR.

499. Parasitology (4) GC S Etiology, distribution, symptomatology, pathology, epidemiology, diagnosis, and control of parasites of man and domestic animals, with emphasis on the evolution of parasitism and host-parasite relationships. P, sixteen units of bio. (Identical with V.Sc. 489)


523. Cytogenetics (3) II Investigation into the structure and function of chromosomes and their role in heredity and evolution. 2R, 3L. P, 320.

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)

525. Speciation (2) [Rpt.] II Mechanisms of evolution in the formation of races and species of animals and plants. P, 320.


540. **Advanced Studies in Marine Biology** (2) [Rpt.] I Analysis and discussion of current advances in the marine biological sciences.

542. **Marine Ecological Research** (4) I Distribution and abundance of marine organisms in relation to physical, chemical, and biotic factors of their environments; emphasis on directed, original research problems and preparation of manuscripts for publication. 2R, 3L. Weekend field trips. P, 102.

547. **Ecology of Wildlife Reproduction** (2) GC II (Identical with W.F.Sc. 547)

580. **Selected Studies in Malacology** (2 to 4) [Rpt.] II Recent advances in malacology. 2R, 6L. Field trips. P, 480.

584. **Selected Studies of Birds** (2) [Rpt.] I Recent advances in ornithology. 1R, 3L or field trip. P, 484. (Identical with W.F.Sc. 584)


596. **Seminar**
   a. Evolutionary Ecology (1 to 2) [Rpt./5] I.
   b. Population Biology (1) [Rpt./6] II Open to majors only.
   c. Macroevolution (2) [Rpt./4] II.

610a-610b. **Research in Ecology and Evolution** (2-2) Introduction to the research currently being pursued by faculty and staff in the dept. 6L. 610a: Three-day field trip. Open to majors only.

620. **Applications and Techniques of Human Genetics** (3) I (Identical with Gene. 620)

670. **Recent Advances in Genetics** (2) I (Identical with Gene. 670)

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**ECONOMICS**

Professors Edward E. Zajac, Head, Gerald O. Bierwag, Phillip J. Bryson, John E. Buehler, James C. Cox, Helmut J. Frank (Emeritus), Bernard P. Herber, Jimmye S. Hillman (Agricultural Economics), Reka P. Hoff (Law), Philip G. Hudson (Emeritus), Robert H. Marshall, Leahmae McCoy (Emerita), Ronald L. Oaxaca, Kenneth R. Smith, Vernon L. Smith, Lester D. Taylor, Donald A. Wells

Associate Professors Michael K. Block (Management and Policy), Jon B. Christianson (Management and Policy), David A. Conn, John Z. Drabicki, Donald G. Heckerman, R. Mark Isaac, Gary D. Libecap, James C. McBrearty, David E. Pingry, Gerald J. Swanson, Carol Taylor, Ronald J. Vogel (Management and Policy)

Assistant Professors Eskander Alvi, Kevin A. McCabe, Sharon B. Megdal, Michael R. Ransom, Stanley S. Reynolds, Fernando M.C.B. Saldanha

The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees with a major in economics. The department also offers supporting work for the Master of Public Administration degree, the Master of Business Administration degree and Doctor of Philosophy degree with a major in business administration. For information concerning these degrees see Requirements for Master's Degrees/Master of Public Administration and Master of Business Administration as well as the Public Administration and 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 421, 422, 501a, 502a, and 597a, and a nine-unit field of specialization. (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 adviser. The student will be given a comprehensive exam over the core program and field. No thesis is required.
All students must complete the core program consisting of 421, 501a-501b, 502a-502b, 503, 520, and 522a-522b and twelve units of 696 economics seminar courses. A minimum of 66 hours is required.

401. **Studies in Microeconomics** (3) GC II Studies in microeconomics, such as the economics of imperfect information and uncertainty, externalities and public goods, and imperfect competition. P, 361, Math. 125b.

405. **Comparative Economic Systems** (3) GC II Analysis of economic policy in market (capitalist) economies and of economic ideology and planning in command (Soviet-type) economies. P, 300 or 361.

406. **Introduction to Experimental Economics** (3) GC II Lab. experimental studies of economic behavior; applications to monopoly, bilateral bargaining, and competitive markets under various exchange rules; speculation, voting processes, public goods. 2R, 3L. P, 210 or 300 or 361.

409. **Economic Anthropology** (3) GC II (Identical with Anth. 409)

411. **Economic Development** (3) GC II Analysis of the economic development process of newly developing nations. P, 201b or 210.

412. **Agricultural Economic Development in Latin America** (3) GC II (Identical with A.Ec. 412)

421. **Introduction to Mathematical Economics** (3) GC I 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 upper-division units in econ.; Math. 125b.

422. **Introduction to Econometrics** (3) GC 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. P, 439 or M.A.P. 375.

435. **Public Sector Economics** (3) GC II The influence of governmental revenue and expenditure decisions on resource allocation, income distribution, and aggregate economic performance. P, 201b or 210.

436. **Economics of Fiscal Federalism** (3) GC II Study of the economics of intergovernmental fiscal relationships in a federal system inclusive of allocational, distributional, and aggregate economic effects. P, 435.

441. **International Trade Theory** (3) GC II General equilibrium analysis of product and input markets of international trade, tariffs, commercial policy, and growth and the welfare aspects of each. P, 300 or 361.

442. **International Economics** (3) GC I Financial aspects of international trade relations and commercial policy. P, 300 or 330.

460. **Economic Organization and Governmental Policy** (3) GC I Structure, conduct, and performance of American industry; governmental institutions and policies affecting business. P, 300 or 361; 439.

461. **Economics of Regulated Industries** (3) GC II Economic analysis of the regulated sector of the American economy, including communications, transportation and energy industries; impact of existing and alternative public policies. P, 300 or 361.

476. **Natural Resource Economics** (3) GC II (Identical with A.Ec. 476)

481. **Economics of Wage Determination** (3) GC I Applications of economic theory and empirical methods to labor supply and demand, investment in human capital, minimum wages, union effects on relative wages, and labor market discrimination. P, 300 or 361.

482. **Labor and the Economy** (3) GC II Macro aspects of labor economics: unemployment — causes and cures; unemployment and inflation; distribution of income. P, 300 or 361.

483. **Urban Economics** (3) GC II Problems of metropolitan areas; evaluation of alternative solutions. P, 201b or 210. (Identical with B.I.S. 483)

484. **Regional Economics** (3) GC I Location theory, regional growth, techniques of regional analysis. P, 300 or 361.

487. **Health Economics** (3) GC II A study of pricing, allocation, and distribution in the health-care industry, with particular emphasis on the economic effects of current governmental policy. P, 201b.
DEPARTMENTS AND COURSES OF INSTRUCTION

497. Workshop
   a. Economics Education Workshop (2) GC S Consult instructor before enrolling.
   b. Summer Institute on the American Economy (3) GC S Consult instructor before enrolling.
   c. Economics Issues for Teachers (3) GC S Consult instructor before enrolling.

500a–500b. Micro-Macroeconomics (3-3) 500a: Theory of price and its application. P, Math. 117e. 500b: Theory of income, employment, interest rates and the price level. Both 500a and 500b are offered each semester. Advanced degree credit available for nonmajors only. Open only to students admitted to a BPA graduate program.


503. Development of Economic Theory (3) II Development of economic thought from ancient times to the present. P, 300 or 361.

504. Production Economics (3) I (Identical with A.Ec. 504 )

511. Microeconomic Theory and Behavior (3) I Microeconomic theory with an emphasis on the use of experimental laboratory and field methods for testing the behavioral implications of the theory. P, 520, Math. 125a, 125b.

512. International Agricultural Economic Development (3) II (Identical with A.Ec. 512 )

513. Agricultural Price and Marketing Analysis (3) II (Identical with A.Ec. 513 )

514. Cost-Benefit Analysis (3) II (Identical with A.Ec. 514 )


520. Theory of Quantitative Methods in Economics (3) II Introduction to the basic concepts of statistics and their application to the analysis of economic data. P, 421.

522a-522b. Econometrics (3-3) 522a: Least squares estimation, statistical inference in the linear regression model. P, 520. 522b: Simultaneous equation estimation, identification, forecasting with econometric models; Bayesian econometrics.

534. Public Finance (3) I II The study of public fiscal economics, with emphasis on relevant topics for public administration and urban planning grad. students: public goods, tax and nontax revenues, intergovernmental issues, benefit-cost analysis. P, 500a.

553. Business and Economic Forecasting (3) II Forecasting techniques used in business; assembly, interpretation and use of economic data; analysis of business conditions; examination of related environmental factors; construction of actual industry sales forecasts. P, 500b, M.A.P. 552. Advanced degree credit available for nonmajors only.

560. Theory and Institutions in Industrial Organization (3) I II S Major issues in the field of industrial organization. Theoretical issues presented with complementary material dealing with specific American industries. P, 500a.

576a-576b. Advanced Natural Resource Economics (3-3) (Identical with A.Ec. 576a-576b )

597. Workshop

696. Seminar
   a. Experimental Economics (1 to 3) I II 2R, 3L. P, 501b.
   b. Mathematical Economics (1 to 3) I II P, 421, 501b, 502b.
   c. Advanced Microeconomic Theory (1 to 3) I II P, 501b.
   e. Advanced Econometrics (1 to 3) I II P, 522b.
   f. Monetary Economics I (1 to 3) P, 502b.
   g. Monetary Economics II (1 to 3) I II P, 696f.
   h. Labor Economics I (1 to 3) I P, 501a; or 361 and 421.
   i. Labor Economics II (1 to 3) I II P, 501a; or 361 and 421.
   j. Public Sector Economics I (1 to 3) I P, 501a; or 361 and Math. 123.
   k. Public Sector Economics II (1 to 3) II P, 501a; or 361 and Math. 123.
   l. International Trade and Finance I (1 to 3) I II P, 421; 361 or 501a.
   m. International Trade and Finance II (1 to 3) I II P, 300, 330, or 361.
   n. Economic Growth and Development I (1 to 3) I II P, 501a, 502a.
Within the College of Education programs are offered leading to the Master of Arts (M.A.), Master of Education (M.Ed.), Master of Science (M.S.), Master of Teaching (M.T.), Educational Specialist (Ed.S.), Doctor of Philosophy (Ph.D.), and Doctor of Education (Ed.D.) degrees as indicated in the following list of departments and majors:

**Business and Career Education**
- *business education* ............................................................. M.Ed.
- *distributive education* ....................................................... M.Ed.

**Counseling and Guidance**
- *counseling and guidance* ..................................................... M.A./M.Ed./Ph.D./Ed.D.

**Educational Foundations and Administration**
- *foundations of education* .................................................... M.A./M.Ed./Ph.D./Ed.D.
- *bilingual/bicultural education* ............................................. M.A./M.Ed.
- *educational administration* ............................................... M.A./M.Ed./Ed.S./Ph.D./Ed.D.

**Educational Psychology**
- *educational psychology* ..................................................... M.A./M.Ed./Ed.S./Ph.D./Ed.D.

**Elementary Education**
- *educational media* ............................................................ M.Ed./Ed.S.
- *elementary education* ....................................................... M.A./M.Ed./M.T./Ed.S./Ph.D./Ed.D.

**Higher Education**
- *higher education* ............................................................. M.A./M.Ed./Ph.D./Ed.D.

**Library Science**
- *library science* ............................................................... M.L.S.

**Reading**
- *reading* ........................................................................ M.A./M.Ed./Ed.S./Ph.D./Ed.D.

**Rehabilitation**
- *rehabilitation* ................................................................... M.S./Ph.D./Ed.D.

**Secondary Education**
- *general biology, chemistry, English,*
  *French, geography, German,*
  *health education, history, family and consumer resources, Latin,*
  *mathematics, Oriental studies, physics,*
  *Russian, Spanish, speech communication, etc.*
  *(most subjects commonly taught in secondary schools)* ............. M.Ed.
- *secondary education* .......................................................... M.A./M.Ed./M.T./Ed.S./Ph.D./Ed.D.
- *educational media* ............................................................. M.Ed./Ed.S.

**Special Education**
- *special education* ............................................................... M.A./M.Ed./Ed.S./Ph.D./Ed.D.

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EDUCATIONAL FOUNDATIONS AND ADMINISTRATION


Associate Professors Kenneth F. Gose, Jr. (Acting Head), Lee A. Droegemueller, Stanley Pogrow, Donal M. Sacken, Macario Saldate IV (Director, Mexican American Studies and Research Center)

Assistant Professors Arminda Fuentevilla (Director, Bilingual Programs), Marcello Medina, Jr.

The department offers programs leading to the Master of Arts and the Master of Education degrees with majors in bilingual/bicultural education, educational administration, and foundations of education. The Educational Specialist degree is offered with a major in educational administration. The Doctor of Education and the Doctor of Philosophy degrees are offered with majors in educational administration and in foundations of education. A doctoral program in educational foundations or administration emphasizing bilingual/bicultural education is offered. Students seeking institutional recommendation for Arizona administrative certification must enroll in a graduate degree program.

An undergraduate grade-point average of at least 3.00 is required for admission to full graduate standing in a master's degree program; however, Arizona applicants with averages above 2.50 may be admitted to provisional standing. Applicants for admission to a specialist or doctoral degree program must have an undergraduate grade-point average of at least 3.00, a graduate grade-point average of at least 3.333, and satisfactory scores on the aptitude test of the Graduate Record Examination. Applicants for specialist or doctoral programs are required to submit a personal data form, three or more letters of recommendation, and some evidence of competency in written and oral communication skills. Applicants wishing to begin graduate work with either the summer session or the fall semester must complete their application files by March 1. Those intending to begin with the spring semester must complete their application files by November 1.

A thesis is required for the Master of Arts degree. Doctoral degree programs, in addition to course work and dissertation, require participation in a variety of professional activities selected by the student in consultation with the advisory committee. Two foreign languages or one foreign language with high proficiency or one foreign language plus nine units of course work approved by the major adviser in subjects collateral to the major field are required for the Doctor of Philosophy degree. Courses taken as a part of this last option are excluded from the graduate study program and are in addition thereto. Equivalent courses completed at other institutions may, if they meet all conditions, including time limitations, be used for satisfying this option. Grades for courses taken to satisfy this option may be excluded from the graduate grade-point average if they are declared, in the Office of the Graduate College, as “not for graduate credit” at the time of enrollment for the course(s) in question. Additional degree requirements for each of the available majors are given below.

Majors

**BILINGUAL/BICULTURAL EDUCATION** — This program is designed for those who are teaching children whose native language is Spanish and whose knowledge of English is limited. Interested students should consult the Director, Bilingual Programs. All students are required to complete 427, 540, 603, 625; Engl. 408; Rdnng. 508; Elem. 528; and Span. 441 and 473. Doctoral students in educational foundations or administration emphasizing bilingual/bicultural education are required to complete 794b and 796b. Spanish Proficiency Test required for Arizona State endorsement in bilingual education.
EDUCATIONAL ADMINISTRATION — Certification programs are available which lead to professional careers as superintendents of schools, principals of elementary and secondary schools, instructional supervisors, and school business managers. Programs leading to other specialized administrative positions may be arranged on an individual basis. A master's degree (any field) is prerequisite for admission to a doctoral program. All students are required to complete 603 or the equivalent. Doctoral students are also required to complete Ed.P. 640 and at least one semester of 796a.

FOUNDATIONS OF EDUCATION — Concentrations are available in history of education, philosophy of education, comparative education, and social foundations of education. A master's degree (any field) is prerequisite to admission to a doctoral program. All students must complete 489, 603, 606, 610, 612, 678, and 695m or 695n. Doctoral students are also required to complete Ed.P. 640 and at least one semester of 796a.

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401. Environmental Education (3) GC I II (Identical with Geos. 401)
403. Study of Exceptional Children (3) GC I II (Identical with Spec. 403)
408. English as a Second Language in Bilingual Education (3) GC I II (Identical with Engl. 408)
411. Public Administration and the Mexican American (3) GC I (Identical with M.A.P. 411)
429. Pedagogical Linguistics: Applied Linguistics for Language Teachers (3) GC II (Identical with Or.S. 429)
437. Issues in Indian Education (3) GC II An interdisciplinary approach to give school administrators, teachers, students, and laymen insight into the governmental, anthropological, public school, and Indian points of view relating to Indian education. (Identical with A.In.S. 437)
465. Educational Program Management (3) GC I Program planning, management, and evaluation for educationally related positions.
476. Philosophical Foundations of Education (3) GC II Introduction to philosophy as general educational theory; logic for teachers, major philosophic thinkers, value theory and epistemology.
488. Microcomputer Application in Education (3) GC I II S The microcomputer as the object and medium of instruction and as a management tool in the school setting; special emphasis on advanced programming techniques, Disk Basic, and Disk operating systems. P. 487. (Identical with B.C.Ed. 488, Ed.P. 488, Elem. 488, L.I.S. 488, Rdg. 488, Rhab. 488, S.Ed. 488, Spec. 488)
489. Anthropology and Education (3) GC I II The application of anthropological theory and methodology to education. (Identical with Anth. 489)
508. Bilingual Reading (3) I (Identical with Rdng. 508)
540. Issues in Educating Mexican American Children (3) I S The application of social science theory and methodology to the issues of educating American children of Mexican heritage; examination of the research and related literature concerning the goals of education in a pluralistic society, cross-cultural education, and bilingualism.
567. Law for Teachers and Student Personnel Workers (3) II Law in the school and university setting; nature of the legal process; forces behind law and education; law and education as social processes and institutions; legal rights and responsibilities. (Identical with Coun. 567, Elem. 567, S.Ed. 567)
581. Human Relations Training (3) GC I II (Identical with Coun. 581)

601. Current Problems in Education (3) I II The problems found in current educational literature, research studies, and school reports.

603. Introduction to Educational Research (3) I II Research techniques in education, interpretation of data and the reporting of results.

604. Educational Administration in Anthropological Perspective (3) I The application of anthropological field techniques and theory to specific educational problems associated with school administration. (Identical with Anth. 604)

605. Social/Cultural Perspectives of School Administration (3) I II The use of social science theory and methodology in analyzing school administration problems and solutions.

606. Comparative Education (3) I II Emphasis on comparative education methodology; analysis of selected national education systems, with focus on sociocultural foundations; curriculum and instruction; administration; teacher education; contemporary trends and issues; implications for education in the United States.

607. Pragmatic Philosophies of Education (3) I Intensive analysis of modern philosophies and their relationships to American educational thought; the emergence of the "pragmatic" curriculum.

610. Philosophy of Education (3) I II Analysis of values and conflicts in American culture as these direct educational policy; critical examination of contending philosophies in the light of democratic ideals.

611. History of Western Education (3) I II The historical development of western educational thought from its origins to the present.

612. History of Education in the United States (3) I II The development of American educational thought from its colonial origin to the present.

614. State School Systems and School Law (3) I II Legal provisions for the government of state school systems; legal basis of local, state and federal relations in education; legal principles relating to pupils, teachers, and school administrators. P, nine grad. units in ed.

615. Public Relations for Teachers and Administrators (3) I Nature of the school community: interagency relationships, influence and use of media, public opinion polls, public relations programs.

616. General School Administration (3) I Organization structures and purposes through which societal demands for education are met; administrative competencies and skills. (Identical with Spec. 616)

619. Design of Instructional Media (3) I II (Identical with S.Ed. 619)

620. Education and the Culturally Diverse (3) I II Issues in the education of the culturally, socially, and economically diverse.

625. Educating the Bilingual Learner (3) I S 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. (Identical with M.A.S. 625)

647. The Principalship (3) I S Functions and activities of building-level administrators, with emphasis on instruction, staff development, student services, evaluation, and operational services. (Identical with Elem. 647 and S.Ed. 647)

648. The Superintendency (3) 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. (Identical with Elem. 648 and S.Ed. 648)

664. Theory and Behavior in School Administration (3) I II Theory in administration: patterns of theory classifications; relationship of theory to administrative function and organizational dynamics. P, nine grad. units in ed.f.a. (Identical with Spec. 664)

670. Personnel Administration in Education (3) 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, fifteen grad. units in ed. 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. (Identical with Spec. 671)
672. School Business Management (3) II The general management of school business; administration and accounting of school funds; administration of equipment and supplies; other business operations. P, nine grad. units in school admin.

673. Planning and Maintenance of School Facilities (3) II Problems in the planning, construction, and maintenance of school facilities; visitation and evaluation of school facilities.

675. The Law and American Education (3) I The analysis of educational questions as influenced by legal principles and the case law; effect of legal provisions upon administrative and other educational decisions and upon social policy. (Identical with H.Ed. 675 and Spec. 675)

676. Supervision of the Instructional Program (3) II Purposes of instructional supervision: organization, techniques and skills for supervisory competency.

677. Higher Education and the Law (3) II (Identical with H.Ed. 677)

678. Educational Sociology (3) I II The school as a social institution; social functions of the school; social processes, socialization, and stratification in education; informal and formal systems and the bureaucratic structure of the school.

680. Administrative Leadership (3) I Explores the leadership process in education, including the use of power and authority in relation to existing social, organizational, and behavioral theories. P, fifteen grad. units in ed.f.a.

681. Educational Program Evaluation Principles and Techniques (1 to 3) [ Rpt./1] I (Identical with Ed.P. 681)

683. Curriculum Development and Supervision in Reading (3) I II (Identical with Rdng. 683)

684. Administration of Bilingual Education Programs (3) 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. (Identical with M.A.S. 684)

695. Colloquium
   a. Theory into Practice (1 to 4) I II
   b. The Administrator and the Organization (1 to 4) I III
   c. The Politics of Decision Making (1 to 4) I III
   f. Computer Applications in Educational Administration (1 to 4) I II
   p. Evaluation (1 to 3) I II (Identical with Ed.P. 695p, which is home)
   r. Bilingualism in the United States (3) [ Rpt./3] S (Identical with M.A.S. 695r, which is home.)

697. Workshop
   a. Collective Negotiations (1 to 3) I II (Identical with H.Ed. 697a)
   c. Educational Evaluation (1 to 3) [ Rpt./1] I II
   d. Leadership and the Mexican-American Educator (1 to 3) [ Rpt./1] I II
   n. Problems and Processes in Teacher Appraisal (1 to 3) I II (Identical with S.Ed. 697n)

794. Practicum
   b. Bilingual Education (3) [ Rpt./2] P, 15 grad. units incl. 540, 625. Open only to students majoring or concentrating in bilingual ed. (Identical with Elem. 794b and S.Ed. 794b)

796. Seminar
   a. Educational Administration (1) [ Rpt./2] I II Open to majors only.
   b. Bilingual Education (3) I

EDUCATIONAL MEDIA
(See Elementary Education and Secondary Education)

EDUCATIONAL PSYCHOLOGY


Associate Professors Sarah M. Dinham, Joseph D. Gullo, Rosemary A. Rosser.
The department offers programs leading to the Master of Education, Master of Arts, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees. Applications should be received by March 1 for fall admission and by November 1 for spring admission.

**Degrees**

**MASTER OF EDUCATION** — The Master of Education is essentially a teaching degree. For full graduate admission to this program, applicants must have an undergraduate grade-point average of 3.00. Those with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. Students must complete 24 units within the department plus twelve units of relevant electives. The Graduate Record Examination is not required. Master of Education candidates must pass a written examination at the end of the program of study. No oral examination is required.

**MASTER OF ARTS** — The Master of Arts is also a 36-hour program. Since it is essentially a research degree, a thesis is required. Two to four units will be permitted for the thesis, and thesis units may replace some of the twelve elective units. The Graduate Record Examination is not required. In addition to a written examination, the Master of Arts candidate must pass an oral examination in defense of the thesis.

**EDUCATIONAL SPECIALIST** — The Educational Specialist degree offers a concentration in school psychology. Applicants must present documentation including academic record, scores on the Graduate Record Examination, three letters of recommendation, and fifteen semester hours in professional education. Internships are required.

**DOCTOR OF EDUCATION** — The major in educational psychology for the Doctor of Education is currently under review. For information, please consult the department head.

**DOCTOR OF PHILOSOPHY** — Concentrations are available in learning and development (including early adolescence); research, measurement, and evaluation methodology and school psychology. An internship is required in all concentrations. Professional competency is required of all doctoral candidates in a twelve-unit sequence of statistics and research methods; all doctoral candidates are also required to demonstrate professional competency in either (a) six-unit sequence in computer programming, (b) 9-unit sequence in a relevant cognate area, or (c) an approved language.

All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. Doctoral candidates must complete Ed.P. 640. For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

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414. **Mental Health In Education** (3) GC I II The principles of mental health, with emphasis on effective personal adjustment in educational settings.

487. **Microcomputers in Education** (3) GC I II S (Identical with Ed.F.A. 487)

488. **Microcomputer Application In Education** (3) GC I II S (Identical with Ed.F.A. 488)

500. **Life Span Development** (3) II Dynamics of development, social integration and roles across the life span. Special emphasis on cognitive, emotional, and personality development with concentration on the antecedent events to adult life experiences. (Identical with C.D.F.R. 500)

501. **Advanced Child Development** (3) I II Aspects of growth and development which influence behavior of the school age child; emphasis on current research findings. P; 301.
502. **Advanced Adolescent Development** (3) II Major developmental issues within the adolescent years; emphasis on the importance and design of adolescent research. (Identical with C.D.F.R. 502)

510. **Learning Theory in Education** (3) II Major theories of learning and motivation; emphasis on relationships between theory and practice in the schools.

512. **Individual Differences** (3) II Psychological, social, and biological factors producing human variation and their implications for education. P, 510.

517. **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.

530. **School Psychology** (3) I Roles of the school psychologist; implementing programs in the public schools; and legal and ethical issues in school psychology. 2R, 3L.

540. **Statistical Methods in Education** (3) I II Descriptive, correlational, and inferential procedures for presenting and analyzing school and research data. For students in all fields.

547. **Theories of Human and Family Development** (3) I (Identical with C.D.F.R. 547)

558. **Educational Tests and Measurements** (3) I Theoretical and practical application of psychometric techniques to test construction, analysis, and interpretation of test results. P, 540 or CR.

559. **Testing of Minorities** (3) II Current theoretical, social, and practical issues in the use of norm-referenced tests with individuals from minority cultures.

593. **Internship**
   a. Research and Evaluation (1 to 6) I II
   b. College Teaching (1 to 6) I II
   c. Learning and Development (1 to 6) I II

595. **Colloquium**
   a. Technology in Instruction (1 to 3) I II
   b. Creativity (1 to 3) I II
   c. Preadolescent Development (1 to 3) I II

597. **Workshop**
   a. Development of Values (1 to 3) I II

600. **Theories of Human Development** (3) I History and analysis of psychological theories of human development and a comprehensive overview of major theoretical systems. P, 500 or 501.

610. **Psychological Theory in Educational Practice** (3) I Major theories of psychological thought; strategies for utilizing such theories in educationally relevant research. P, 510.

612. **Cognitive Development** (3) II Cognitive theory and research as they bear upon developmental and educational processes. P, 500 or 501.

614. **Design of Instruction** (3) II Historical and theoretical bases for developing instructional design; emphasis on relationship between learning theory and instructional design. P, 510.

615. **Adult Learning and Development** (3) I (Identical with H.Ed. 615)

618. **Research on Teaching** (3) II To acquaint educational researchers with the models, paradigms, strategies, and empirical research that are the basis for understanding how classroom teaching and learning are related. P, 510, 540, 558.

619. **Design of Instructional Media** (3) II (Identical with S.Ed. 619)

638. **Behavioral Consultation in Educational Settings** (3) I II Principles and techniques of conducting behavioral consultation in educational settings to promote learning and development of children and youth. 2R, 3L. P, 517.

640. **Advanced Statistical Methods in Education** (3) I II Inferential procedures for analyzing educational data; includes nonparametric methods and introduction to multivariate and causal procedures. P, 540.

646. **Multidimensional Methods in Educational Research** (3) II Provides an understanding of and facility with research application of multivariate correlational techniques, such as multiple regression, discriminant function, canonical correlation, and factor analysis. P, 640.

655. **Evaluating Standardized Tests** (3) I Technical standards for evaluating standardized tests and manuals with emphasis on the contemporary state of the field. P, 540, and 558 or CR.
658. **Theory of Measurement (3)** II Advanced topics in theoretical and practical issues in psychometrics. P, 558; 640 or CR.

661. **Computer Applications in Educational Research (3)** II The practical applications of computers to statistical data analysis. P, 640.


671. **Theories of Intellectual Assessment (3)** II Various theories and models of human ability and their implications for intellectual assessment. P, 558 or CR.

672a-672b. **Field Experience in Intellectual Assessment in Education (1-2)** Supervised field experience in the administration, scoring and interpretation of various intellectual assessment devices. 672a: Wechsler Adult Intelligence Scale. 672b: Intellectual assessment techniques. 1R, 3L. Open to majors and minors only. Credit allowed for 672a or 672b, but not for both. P, 671 or CR.

673. **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, 672b.

674. **Psychoeducational Assessment in the Schools (3)** I Psychoeducational assessment techniques; practice in prescribing remedial programs. 2R, 3L. Open to majors and minors only. P, 671, 672b.

681. **Educational Program Evaluation Principles and Techniques (1 to 3)** [Rpt./1] I Development and current viewpoints, political context, illustrative cases, technical skills for determining merit or making decisions about educational and social programs. P, 540, 558, Ed.F.A. 303. (Identical with Ed.F.A. 681)

693. **Internship**
   a. Research and Evaluation (1 to 6) [Rpt./12 units] II
   b. College Teaching (1 to 6) [Rpt./12 units] II
   c. Learning and Development (1 to 6) [Rpt./12 units] II
   d. School Psychology (1 to 6) [Rpt./12 units] II

694. **Practicum**
   a. Research and Evaluation (3) [Rpt./1] II
   b. Learning and Development (3) [Rpt./1] II
   c. School Psychology (3) [Rpt./1] II

695. **Colloquium**
   a. Cognition (1 to 3) II
   b. Cross-Cultural Perspectives (1 to 3) II
   c. Human Development (1 to 3) II
   d. Instructional Technology (1 to 3) II
   e. Learning and Development (1 to 3) II
   f. Motivation for Learning (1 to 3) II
   g. Personality and Adjustment (1 to 3) II
   h. School Psychology (1 to 3) II
   p. Evaluation (1 to 3) II (Identical with Ed.F.A. 695p)

696. **Seminar**
   a. Research Design and Techniques (1 to 3) [Rpt./2] II

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**ELECTRICAL AND COMPUTER ENGINEERING**


Assistant Professor Robin N. Strickland
The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in electrical engineering. Masters's degree students may also select one of the following interdisciplinary options: biomedical engineering, clinical engineering, energy systems engineering, or materials engineering. For details concerning these options see Engineering elsewhere in this catalog.

Each applicant is required to submit scores on the general test of the Graduate Record Examination taken within the last five years. In addition, applicants for the Ph.D. program will be required to submit a detailed statement of professional goals, and three letters of recommendation from instructors who are in a position to predict the applicant's potential as a graduate student.

For the Master of Science degree, the required thirty units must include at least fifteen units (other than the thesis) in the major field, and no more than nine of these may be at the 400 level. Under Plan "A," the student is required to submit a six-unit thesis as part of the 30 units and pass a final oral examination. Under Plan "B," the student is required to complete at least six units in electrical engineering in lieu of a thesis and to pass a comprehensive examination. Exceptions to these requirements are made for students selecting one of the interdisciplinary options identified above. Additional details concerning the requirements for the master's or doctoral degrees may be obtained on request from the department.

A program for highly-qualified students with degrees in other fields is available. Under this program it is possible to remove undergraduate deficiencies and complete requirements for a master's degree in as little as two and one-half years. Additional information concerning this program may be obtained on request from the department.

411. Electronic Instrumentation (1 to 3) GC II Individualized instructional units in specific areas: light, temperature, psychometry, reference electrodes, gas analysis, basic electric circuits, signal processing. P, college phys.

415. Medical Instrumentation (3) GC I Basic concepts of instrumentation and measurement; principles of transducers, operational amplifiers and instrument systems, with emphasis on biomedical measurements; lab. experiments with transducers and medical equipment. 2R, 3L. P, sr. engr.

417. Clinical Engineering (3) GC II Activities and responsibilities of clinical engineers; hospital facilities, medical equipment specifications and control, safety, management, health care, and developing and selling new ideas. Field trips. P, 208 or 351 b. (Identical with A.M.E. 417)

418. Physiology for Engineers (4) GC I (Identical with Psio. 418)

419. Physiology Laboratory (2) GC I (Identical with Psio. 419)


426. Modern Filtering and Signal-Processing Techniques (3) GC II Operational amplifier circuits; basic active RC filter design; nonlinear wave shaping; analog switches; A/D and D/A conversion. P, 321b.

428. Digital Signal Processing (3) GC I Discrete-time systems and difference equations; time and frequency analysis, Z-transforms; sampling and data reconstruction; modern design of digital filters. P, 305, 321b, Math. 322.

431. Principles of Communication Systems (3) GC I II Signal analysis techniques associated with modulation and demodulation in systems such as AM, FM, and PCM, with special emphasis on digital communication. P, 321b, 351b.


434. Electrical, Magnetic and Optical Properties of Materials (3) GC I 1986-87 (Identical with M.S.E. 434)

436. Introduction to Coding Techniques (3) GC II Error-correcting codes used in modern digital communications systems, with emphasis on hardware implementations and performance on real channels.

441. Automatic Control (3) GC I II Linear control system representation, analysis, stability and design. P, 305, 321b.
442. Digital Control Systems (3) GC II Modeling, analysis, and design of digital control systems; A/D and D/A conversions, Z-transforms, time and frequency domain representations, stability, microprocessor-based designs. P, 441.

452. Solid-State Device Design (3) GC II Properties of semiconductors, impurity behavior, solid-state effects; the operation of p-n junctions, transistors, photocells, tunnel diodes, surface devices. P, 381.

455. Elementary Digital Circuit Design (3) GC II Emphasis on first-order analysis and design; integrated bipolar digital and MOS logic circuits. P, 351b.

457. Integrated Circuit Technology Laboratory (3) GC I II Theory of and experiments in diffusion, oxidation, etc.; fabrication of an integrated circuit. (Identical with M.S.E. 457)

458. Solid-State Circuits (3) GC I Intermediate level circuitry and devices, with applications ranging from DC to the microwave and optical regions; consideration of discrete and integrated circuits. P, 321b, 351b.

459a-459b. Laser Engineering (3-3) GC 459a: Introduction to lasers, laser radiation and laser applications. 459b: Quantum elements plus fusion, weapons, holography and space communications P, 351a, 381.

461. Energy Conversion (4) GC I Principles and operating characteristics of rotating machinery and electromagnetic transducers, single-phase and polyphase transformer operation, laboratory demonstrations and tests of transformers and rotating machinery. P, 321b, 381.


465. Current Problems in Energy and Power (1 to 4) [Rpt./1] GC II (Identical with N.E.E. 465)

466. Solar Energy Engineering (3) GC I (Identical with N.E.E. 467)

472. Continuous-System Simulation (3) GC I Interdisciplinary introduction to continuous-system simulation, mainly digital; modeling, state equations, languages, sensitivity and optimization. P, 305. (Identical with C.Sc. 472)

474. Digital Logic Design (3) GC II Truth-functional calculus, Boolean algebra, map tabular minimization, coding, synthesis of sequential circuits, selected lab. exercises. 3R, 3L. P, 271b or C.Sc. 476. (Identical with C.Sc. 474)

475. Microcomputer-Based Design (3) GC I II Design of microprocessor-based real-time test and control systems, use of development systems and emulators. 2R, 3L. P, 372.

476. Computer Architecture (3) GC I (Identical with C.Sc. 476)

477. Environmental Impact of Energy-Related Systems (3) GC II (Identical with C.E. 477)

478. Data Communications Networks (3) GC I Characteristics of ISO Open Systems Interconnection Reference Model; design of broad band and baseband network interfaces; features of network, transport, session, and presentation layers; Ethernet and IEEE 802 interface. P, 371, 372 or equivalent.

481. Microwave Measurements (3) GC II Measurement techniques and applications of devices used in microwave research. 2R, 3L. P, 381.

482a-482b. Electromagnetic Applications (3-3) GC Special functions, boundary value problems, potential theory, transmission lines and in wave guides, resonant cavities, power flow in propagating waves, antennas and radiation. P, 381 or Phys. 415a.

497. Workshop

501. Linear Systems Theory (3) I Techniques for the analysis of continuous and discrete-time linear systems; state variable representation, time domain and frequency domain methods; Laplace, Fourier, Z-transforms.

502. Analytical Methods in Electrical Engineering (3) I Electrical engineering phenomena in terms of partial differential equations; solutions by Green's functions, eigen function expansions, and transform methods; the special functions, including Bessel and Legendre functions; application to practical analysis problems.
503. Introduction to Statistical Communication Theory, Random Processes, and Noise (3) I Probability, random variables, stochastic processes, and their relation to communications systems analysis; correlation functions and spectra, impulse noise and other simple random wave forms, noisy networks.

504. Optimal Control of Dynamic Systems (3) II 1985-86 (Identical with A.M.E. 504)

505. Modern Control Theory (3) II 1986-87 (Identical with A.M.E. 505)

515. Advanced Medical Instrumentation (3) II Concepts and design of transducers, instrumentation and measurement systems, with emphasis on biomedical technology; research project on lab. computer. 2R, 3L.

521. Network Synthesis (3) I Synthesis of active and passive low-, high-, and band-pass network functions, time and frequency domain approximation, use of optimization techniques, properties of distributed elements.

522. Active RC Filters (3) II Modern techniques for realizing active RC filters, using lumped and distributed elements and operational amplifier gain blocks; determination of sensitivity.

531. Image Processing Laboratory (3) I Introduction to hardware and software used in image processing: image sampling and display systems, principles and applications; image processing software for image enhancement and information extraction; applied problems in natural resources, remote sensing. 3R, 3L. (Identical with Opti. 531)

533. Image Processing: Devices, Systems and Applications (3) II 1985-86 (Identical with Opti. 533)

534. Advanced Electronic, Magnetic and Optical Materials (3) II 1986-87 (Identical with M.S.E. 534)

539. Algebraic Coding Theory (3) II 1985-86 (Identical with Math. 539)


545. Decentralized Control and Large-Scale Systems (3) II Introduction to large-scale systems, definitions and special problems, modeling and model reduction, structural properties, decentralization of control and information, hierarchical and multi-level controllers. P, 501.


552. Linear Circuit Design (3) I Design of discrete and integrated solid-state circuits for small-signal applications; flow graph analysis; DC operational and wide-band amplifier design; power amplifier design.

553. Active Linear Circuit Design (3) II I.F. and R.F. band-pass amplifier design using solid-state devices; stagger-tuned I.F. amplifier and UHF band-pass amplifier design methods; fundamental concepts of design engineering. P, 552.

555. Layout Engineering for Integrated Circuits (3) I Development of layout ground rules; circuit design and layout methods for low sensitivity to parameter variations; use of SPICE and UAMASK programs for circuit simulation and layout. P, 457 or 458.

556. General Physical Electronics (3) I Fundamentals of plasma, solid-state and optical electronics. Specific topics include lasers, thermoelectricity, solid-state and plasma devices.

558. Advanced Integrated Circuits Laboratory (3) I All phases of design and fabrication of a modern integrated circuit are considered and applied in the fabrication from concept to final test. 1R, 6L. P, 457, consult dept. before enrolling.

567. Advanced Solar Engineering (3) II (Identical with N.E.E. 567)

569. Energy Use: Analysis and Management (3) I (Identical with N.E.E. 569)

571. Digital Systems Design (3) I I Computer organization, memory systems, AHPL, control unit design, microprogramming, input-output, computer arithmetic, features of large computers, time sharing. P, computer programming. (Identical with C.Sc. 571)


577. Computer Aided Engineering for Integrated Circuits (3) I Industrial CAD systems for integrated circuits; programs for process and device simulation; terminal models of bipolar and MOS devices, automated circuit analysis, methods, programs, use of computer graphics. P, 452, 455.

581. Electromagnetic Field Theory (3) I Development and application of electromagnetic field theory required in advanced studies; topics chosen to apply to many electrical engineering subdisciplines.

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, 482a or other introductory electro-magnetic course.

584. Antenna Theory (3) II 1985-86 Electromagnetic radiation and diffraction; dipoles, slots, open waveguides, and horns; apertures, reflectors, and arrays; mechanical and electronic scanning; applications to practical radar and communications problems. P, 581.

589. Atmospheric Electricity (3) II 1986-87 (Identical with Atmo. 589)

636. Information Theory and Coding (3) II 1986-87 Definition of a measure of information and study of its properties; introduction to channel capacity and error-free communications over noisy channels; encoding and decoding systems, with emphasis on error correcting and error detecting codes for noisy binary channels. P, 503. (Identical with Math. 636)

639. Methods of Communication and Detection Theory and Signal Extraction (3) II 1985-86 Communication, detection and measurement as statistical decision problems; principles of communication in the presence of noise; discussion of AM, FM, and PCM; matched filter and correlation detection; coherent detection, phase-locked loops. P, 503.

652. Analysis and Design of Semiconductor Junction Devices (3) II 1985-86 Analysis of physical phenomena in semiconductors, including carrier transport, injection, and lifetime, with emphasis on how these phenomena affect design and operation of junction devices. P, 556.

653. Advanced Device Engineering (3) I 1985-86 Consideration of the design of devices: photoconduction, photovoltage, tunneling, surface effects, junction avalanche, solid-state microwave generation, thermosemiconductors and Hall effect.

674. Sequential Circuits and Automata (3) I Analysis and synthesis of sequential circuits, partitioning and state assignment, linear sequential circuits, iterative networks, fault test generation and design automation. P, 474. (Identical with C.Sc. 674)


685. Inertial Confinement Controlled Fusion (3) I (Identical with N.E.E. 685)

687. Magnetic Confinement Controlled Fusion (3) II (Identical with N.E.E. 687)


693. Internship
   c. Clinical Engineering (2 to 3) II P, enrollment in clinical engr. option.

ELEMENTARY EDUCATION

Professors Edward D. Brown, Head, Joseph Fillerup, Kenneth Goodman, Yetta Goodman, Bill J. Ranniger
Associate Professors Ruth A. Beeker, Vivian E. Cox, Willis Horak, Carol Larson
Assistant Professors Richard Lopez, Alice Paul, Guadalupe Romero

The department offers programs leading to the Master of Arts, Master of Education, Master of Teaching, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in elementary education. The department also offers programs leading to the Master of Education and the Educational Specialist degrees with a major in educational media. A minor program is also available for doctoral students with majors in other disciplines.
Applicants for master's degree programs may be required to submit scores on the Miller Analogies Test. Applicants for specialist and doctoral degree programs must submit scores on the aptitude and advanced (education) tests of the Graduate Record Examination, a personal data blank, and letters of reference to the Office of Graduate Studies in Education.

Graduate study programs are individually planned with each student to fulfill individual academic and professional objectives. These programs draw heavily on interdisciplinary course work. A thesis is required for the Master of Arts degree. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. Doctoral candidates must complete Ed.P. 640.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as a result of the review.

403. Study of Exceptional Children (3) GC I II (Identical with Spec. 403)
408. English as a Second Language in Bilingual Education (3) GC I II (Identical with Engl. 408)
417. Media in Instruction (3) GC I II S (Identical with S.Ed. 417)
427. Bilingual/Bicultural Education Curriculum Development (3) GC I II (Identical with Ed.F.A. 427)
487. Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487)
488. Microcomputer Application in Education (3) GC I II S (Identical with Ed.F.A. 488)
497. Workshop
  g. Creative Arts for Native Americans (3) GC I II
526. Methods and Materials in Bilingual Education (3) I II Evaluation and study of methods and materials used in bilingual education programs. (Identical with S.Ed. 526 and Spec. 526)
531. Career Education (3) I (Identical with Coun. 531)
534. Learning Through Play (3) I II S Play theories as they relate to early childhood development, parenting, and curriculum design.
561. History of Children's Literature (3) II (Identical with Li.S. 561)
567. Law for Teachers and Student Personnel Workers (Identical with Ed.F.A. 567)
595. Colloquium
  c. Language Experiences in Learning (3) II S P, 322. (Identical with S.Ed. 595c)
597. Workshop
  a. Evaluating the Elementary School (1 to 3) II S P, Ed.P. 301 or 310.
  c. Elementary School Science (1 to 3) [ Rpt./1] I II S P, Ed.P. 301, 310.
  e. Newspaper in the Classroom (1 to 3) II S P, Ed.P. 301 or 310. (Identical with S.Ed. 597e)
  f. Investigating the Environment (1 to 3) II S P, Ed.P. 301 or 310. (Identical with S.Ed. 597f)
  n. Miscue Analysis in Teacher Education (2 to 3) II 1986-87
  r. Curriculum for Self Development (3) S (Identical with S.Ed. 597r, which is home)
  w. Southern Arizona Writing Project (3-9) [ Rpt./12 units] I II S (Identical with S.Ed. 597w, which is home)
613. Teaching of ESL (3) I (Identical with Engl. 613)
616. Coordination of Instructional Media Programs (3) II (Identical with S.Ed. 616)
617. Preparation of Instructional Materials (3) I (Identical with S.Ed. 617)
619. Design of Instructional Media (3) II (Identical with S.Ed. 619)
620. Science Curriculum in the Elementary School (3) I II Trends in the science curriculum of the elementary school, with emphasis on selection of content, concepts and activities, methods of teaching, needed equipment, and community resources. Primarily for in-service, public-school personnel. P, twelve units of elem.
621. Trends and Issues in Early Childhood Education (3) I II S 1986-87 Trends and issues in contemporary early educational programs with emphasis on changing needs in the home, school and society.
623. Constructing the Elementary School Curriculum (3) I II The elementary school curriculum and its relationships; basic theories and techniques of curriculum construction discussed, evaluated and applied. P, twelve units of elem.


625. Developing the Language Arts Curriculum in the Elementary School (3) I II Trends in the language arts curriculum of the elementary school, with emphasis on linguistic theory and its application to the instructional program. P, twelve units of elem.

626. Social Studies Curriculum in the Elementary School (3) I II Trends in the social studies curriculum of the elementary school, with emphasis on selection of content, grade placement of concepts and activities, methods of teaching, needed equipment, and community resources. Primarily for in-service, public-school personnel. P, twelve units of elem.


629. Investigations in Elementary Education (3) I II Critical study and evaluation of the investigations and experimental evidence basic to the aims and instructional practices of the elementary school.

631. Curricular Studies in School Mathematics (3) II 1986-87 (Identical with S.Ed. 631)

632. Math Diagnosis and Remediation (3) II Techniques for identifying mathematical learning difficulties and strengths; strategies for designing systematic instruction for correcting identified difficulties. 3R, 1L. P, 326.

633. Language Acquisition and Development (3) I Study of the development of language in young children, and exploration of instructional techniques to maximize that development.

634. Day Care Education (3) I History, types, goals, environments, planning for adults, standards and licensing requirements, understanding public responsibility of comprehensive child care. Field trips.

635. Applied Linguistics in Education (3) I The application to curriculum, teaching and learning of concepts from linguistics, psycholinguistics and sociolinguistics.

636. Research Methodology in Educational Linguistics (3) II Applied research methodology using insights from linguistics, psycholinguistics, sociolinguistics and information theory; cognitive and linguistic development in school and life. P, 633 or 635.

637. Application of Miscue Analysis (3) II 1985-86 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, 635, Rdng. 633. (Identical with Rdng. 637)

638. Written Language Development (3) I II S Exploration of the emerging writing and reading behavior of children ages 2-10 and the relationship between oral and written language development through current and original student research. P, 633.

639. Research in Language and Literacy (3) [ Rpt./9 units] II New concepts and research on the nature and function of written language. P, master's degree or consult department before enrolling.

640. Applications of Language and Literacy (3) [ Rpt./9 units] II Contemporary research in language development from pre-school to adult as it relates to school language programs.

644. Parent Education and Involvement (3) I II S Study of models for parent education; exploration of alternative strategies for improving parent/teacher interactions and parent involvement in the learning process.

647. The Principalship (3) I S (Identical with Ed.F.A. 647)

648. The Superintendency (3) II S (Identical with Ed.F.A. 648)

695. Colloquium
b. Early Childhood Education (1 to 4) I II
ENERGY SYSTEMS ENGINEERING
(See Engineering)

ENGINEERING

Within the Colleges of Engineering, Agriculture, and Mines, 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.

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.
   mineral economics ............................................ M.S./Ph.D.

Nuclear and Energy Engineering
   nuclear engineering ........................................... M.S./Ph.D.

Soils, Water and Engineering
   agricultural engineering ...................................... M.S.

Systems and Industrial Engineering
   systems engineering ........................................... M.S./Ph.D.
   industrial engineering ....................................... M.S.

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 options follow.
BIOMEDICAL ENGINEERING — This option is available in the Departments of Aerospace and Mechanical Engineering, Chemical Engineering, Electrical and Computer Engineering, and Nuclear and Energy 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 and 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.

ENGINEERING MECHANICS

(See Civil Engineering and Engineering Mechanics)

ENGLISH


Assistant Professors Carl Berkhout, Dhira Mahoney, Duane Roen, Alice M. Senob (Emerita), Leslie Marmon Silko, Carolyn Jan Swearingen, Charlotte Thompson, Thomas Willard, Lynda Zwinger

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. In cooperation
with the College of Education, the department also offers work leading to the Master of Education degree with a major in English and the Doctor of Philosophy degree with a major in English education. A specialized Master of Arts degree is available to meet the requirements for teacher certification in Arizona community colleges.

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 as a second language) — No Graduate Record Examination scores are required, but applicants must present evidence of the completion of two years of college study in a foreign language or demonstrate equivalent proficiency by examination.*

MASTER OF FINE ARTS — For information concerning this degree see Requirements for Master's Degrees/Master of Fine Arts elsewhere in this catalog.*

MASTER OF EDUCATION — Applicants must have completed an undergraduate major or minor in English, including a minimum of twenty units in English with a year's survey of English literature, a course in the history of the English language, and a course in modern grammar. Graduate Record Examination scores may be required of applicants whose undergraduate preparation seems weak. For further information concerning this degree see Requirements for Master's Degrees/Master of Education 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 in English and American literature equivalent to the final examination for the Master of Arts degree with high pass performance. The dissertation for students with English majors may take the form of three extended essays. The dissertation for students with English education majors will normally take that form.*

*Details of specific departmental requirements for the various degree programs should be obtained from the Director of Graduate Study of the Department of English.

401. Advanced Nonfiction Writing (1 to 4) [ Rpt./2] GC I II P, 301.
403. Advanced Scientific Writing (3) GC I II Preparation of professional literature for publication.
404. Advanced Fiction Writing (1 to 4) [ Rpt./2] GC I II P, 304.
405. History of the English Language (3) GC I II The evolution of English sounds, inflections, and vocabulary from earliest times to the present, with attention to historical conditions. (Identical with Ger. 405 )
406. Modern Grammar and Usage (3) GC I II Current American English structure according to major types of grammar and current American English usage, both with reference to standard British English.
408. English as a Second Language in Bilingual Education (3) GC I II Methodology for the teaching of English as a component of bilingual education; grammar, phonology, and syntax as they apply to the teaching of language skills. (Identical with Ed.F.A. 408, Elem. 408 and S.Ed. 408 )
409. Advanced Poetry Writing (1 to 4) [ Rpt./2] GC I II P, 309.
166 DEPARTMENTS AND COURSES OF INSTRUCTION

410. Teaching of Composition (3) GC I II Theory and practice of teaching writing in secondary schools and colleges. P, 306. (Identical with S.Ed. 410)


412. Teaching of the English Language (3) GC I II Theory and practice of teaching various aspects of language in the secondary schools. P, 405, 406. (Identical with S.Ed. 412)

413. Poetry in Forms (1 to 4) GC II Explores English prosody through discussing and writing of major forms, research paper. Open to creative writing majors only. P, 309

419a-419b. The Essay In English (3 - 3) GC 419a: The essay in English. 419b: Other prose forms. P, Freshman Composition; upper division or graduate standing

420. Contemporary American Usage (3) GC I II S Consideration of the varieties of contemporary American language usage, social and regional, written and oral. P, upper division or graduate standing

438. The Indian in the Literature of the Americas (3) GC II 1986-87 Studies of works by and about Indians published throughout the Americas. (Identical with A.In.S. 438)


445. Introduction to TESL: An Overview (2) GC 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.

449a-449b. Folklore (3-3) GC 449a: Forms of Verbal Folklore: myth, legend, folklore, riddle, proverb, jokes, folksong, ballad, etc. 449b: Non-verbal Folklore: custom, belief, folk art and craft, food, medicine, dress, festival, and drama. (Identical with A.In.S. 449a-449b and Anth. 449a-449b)

461. Linguistics and the Study of Literature (3) GC II 1986-87 (Identical with Ling. 461)

469a-469b. Germanic Folklore: An Introduction to Nonliterary Forms (3-3) GC (Identical with Ger. 469a-469b)


515a-515b. History of Criticism (3-3) 515a: Plato through the 19th century. 515b: Modern criticism.

516a-516b. Theories of Linguistic Structure (3-3) 516a: The American tradition in linguistics. 516b: The European tradition in linguistics. 516a is not prerequisite to 516b.

520a-520b. History of the German Language (3-3) (Identical with Ger. 520a-520b)

525. Beowulf (3) II (Identical with Ger. 525)

526. Advanced Studies in Chaucer (3) II


531. Advanced Studies in Shakespeare (3) II

533. Studies in the Renaissance (3) I

534. Advanced Studies in Milton (3) I

541. Studies in the Restoration and Eighteenth Century (3) II

555a-555b. Studies In Nineteenth-Century British Literature (3-3) 555a: The Romantics. 555b: The Victorians.


561. History of Children's Literature (3) II (Identical with Li.S. 561)


<table>
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<tr>
<th>Course</th>
<th>Description</th>
<th>Prerequisites</th>
<th>Notes</th>
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<tbody>
<tr>
<td><strong>591. Preceptorship</strong></td>
<td>a. Methodology of Essay Writing (1)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td></td>
<td>b. Methodology in Critical Reading and Writing (1)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<tr>
<td><strong>595. Colloquium</strong></td>
<td>a. Rhetoric of Exposition (1)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>b. Rhetoric of Literature and Critical Writing (1)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<tr>
<td><strong>596. Seminar</strong></td>
<td>a. Medieval Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>b. Renaissance Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>c. Restoration and Eighteenth-Century Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>d. Nineteenth-Century British Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>e. Twentieth-Century British Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>f. American Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>g. Comparative Literature (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>h. Modern Literature (3)</td>
<td>Open to creative writing majors only.</td>
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<td></td>
<td>i. Germanic Linguistics (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>j. Linguistics for ESL (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>k. Methods and Materials of Literary Research (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>l. Theories of Criticism (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td>m. Studies in the Oral Tradition (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<tr>
<td><strong>597. Workshop</strong></td>
<td>o. The Teaching of English (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td></td>
<td>w. Southern Arizona Writing Project (3-9)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<tr>
<td><strong>604. Writing Project in Fiction</strong></td>
<td>(1 to 6)</td>
<td>For M.F.A. candidates working on the book-length writing project in fiction.</td>
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<tr>
<td><strong>609. Writing Project in Poetry</strong></td>
<td>(1 to 6)</td>
<td>For M.F.A. candidates working on the book-length writing project in poetry.</td>
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<tr>
<td><strong>612. English Grammar for ESL (3)</strong></td>
<td></td>
<td>Problems analysis of ESL: remedial ESL composition. (Identical with S.Ed. 612)</td>
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<tr>
<td><strong>613. Teaching of ESL (3)</strong></td>
<td></td>
<td>Basic approaches to the teaching of English as a second language, with emphasis on the aural-oral method. P, 612 or CR. (Identical with Elem. 613 and S.Ed. 613)</td>
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<tr>
<td><strong>693. Internship</strong></td>
<td>a. Applied ESL (3)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td></td>
<td>b. Linguistics (2 to 4)</td>
<td>Designed for graduate teaching assistants in English.</td>
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<td></td>
<td>c. Folklore (2 to 4)</td>
<td>Designed for graduate teaching assistants in English.</td>
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**ENGLISH AS A SECOND LANGUAGE**
(See English)

**ENGLISH EDUCATION**
(See English)

**ENTOMOLOGY**
Professors William S. Bowers, Head, Paul D. Gerhardt (Emeritus), Roger T. Huber, Leon Moore, William L. Nutting, Donald M. Tuttle (Emeritus), George W. Ware, Theo F. Watson, Floyd G. Werner
Associate Professor Robert L. Smith
Assistant Professors David N. Byrne, L. Irene Terry
The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in entomology. Concentrations are available in apiculture, behavior, biological control, bionomics, ecology, host plant resistance, insect pest management, morphology, physiology, taxonomy, toxicology, and urban entomology.

Admission requirements include the completion of an undergraduate major in entomology or another appropriate field in the biological, physical, or agricultural sciences. The undergraduate program should include course work in the biological sciences, physics, organic chemistry, and statistics or calculus. Applicants must submit scores on the aptitude and advanced 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 guidance committee. Master's degree candidates, regardless of the area of concentration, will be required to have completed courses in systematics, morphology and physiology. A thesis is ordinarily required. The doctoral program requires, in addition to the requirements for the master's degree, courses in biochemistry, computer programming, advanced statistics, and the equivalent of one semester of teaching experience.


402. Introduction to Pesticides and Their Use (2) GC II (Identical with P.I.P. 402)

403R. Biology of Animal Parasites (3) GC I (Identical with V.Sc. 403R)

404. Insect Morphology (4) GC I 1986-87 External and internal anatomy as related to identification, function and phylogeny of insects and other arthropods; modifications in development and habits peculiar to the insects. 2R, 6L. P, three units of ento. or invertebrate zoo. Nutting

407. Insect Physiology (4) GC II 1986-87 Principles of the physiological systems of insects and lab. methods for their study, with emphasis on the functioning of these systems in the environment. 2R, 6L. P, three units of organic or biochemistry.

410. Introduction to Insect Crop Pests (1) GC I Biology, recognition and control of arthropod pests of Arizona's principal agricultural crops. 1R, 3L. Field trips. P, 151 or 201R. Byrne

412. Cultural Control and Host Plant Resistance (1) GC I Analysis of cultural practices used for insect management in crop systems. Principles of insect-plant relationships pertaining to resistance in crop plants, and the methods used to develop resistant crop varieties. 2R. P, one unit in entomology. Terry

414. Insect Biometeorology (1) GC I Effects of meteorological factors on insect populations, with emphasis on the development and use of phenological heat unit models for population prediction. 2R. P, one unit in entomology. Huber

416. Biological Control (2) GC II Principles of the biological control of arthropod pests, with emphasis on their application to agricultural entomology. 2R. P, 434 or a course in population ecology. Watson

418. Insect Vectors of Plant Pathogens (1) GC II Examination of the relationships between insect vectors, plant hosts and crop pests. 2R. P, one unit in entomology. Byrne

420. Urban Entomology (3) GC II 1985-86 Biology of insects, other arthropods and vertebrates, beneficial and pestiferous, that impact humans in the urban ecosystem. Identification of species and management of pests. 2R, 3L. Field trips. Smith

422. Insect Population Sampling (1) GC I Development of sampling methods for both research purposes and pest management decision making. Comparison of the efficiency of sampling methods and programs for sampling data analysis. 1R, 3L. Field trips. P, three units of stat. Terry

424. Biorationals in Crop Protection (1) GC I History, current status and methods of use of pheromones and microbial insecticides in crop protection. 2R. P, one unit in entomology. Huber

430. Chemical Control (1) GC I Examination of the history, methods, externalities and benefits of the use of insecticides and acaricides. 2R. P, one unit in entomology. Byrne

432. Horticultural Crops Insect Pest Management (1) GC I Analysis of methods used to manage arthropod pests of fruit, nut, grape, and vegetable crops. 2R. P, 410. Huber
434. **Insect Population Dynamics** (1) GC II Emphasis on the evaluation of natural regulating mechanisms of agriculturally important insect populations. 2R. P. 422. Huber

436. **Field Crops Insect Pest Management** (1) GC II Analysis of methods used to manage arthropod pests of field crops, including the biological basis, economics and problems associated with various strategies. Emphasis on Arizona crops. 2R. P. 410. Terry

438. **Principles of Insect Pest Management** (1) GC I Principles, concepts, and methods of insect pest management. 2R. P. 412, 422, 430, and 436. Watson

508. **Insecticide Toxicology** (3) II 1985-86 Insecticides and related chemicals; their modes of action, detoxication, resistance in arthropods, and environmental distribution and effects. P, three units of organic or bioc. (Identical with Tox. 508)

512. **Insect Behavior** (3) II 1985-86 The physiological basis of insect behavior, with examples and methods of study of the diverse types of behavior exhibited by insects and other land arthropods. Nutting

516. **Applied Insect Taxonomy** (4) I 1985-86 Principles and methods in the classification of animals. Practice in developing practical classifications of insects that are of significance to crop protection in local areas. Classification of immature stages of terrestrial insects. 3R, 3L. Field trips. Werner

576. **Environmental Toxicology** (3) I (Identical with Tox. 576)

696. **Seminar**
   a. **Entomology** (1) [ Rpt./6] II

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**ENVIRONMENT AND BEHAVIOR**

**Committee on Environment and Behavior (Graduate)**

Professors Robert Bechtel, Chairperson (Psychology), Charles Albanese (Architecture), Warren Anderson (Art), Terry Daniel (Psychology), William Havens (Renewable Natural Resources), Helen Ingram (Political Science), William Ittelson (Psychology), David King (Renewable Natural Resources), Kirby Lockard (Architecture), Thomas F. Saarinen (Geography and Regional Development), Lawrence Wheeler (Psychology), Ervin H. Zube (Renewable Natural Resources)

Associate Professors Dennis Doxtater (Architecture), William Shaw (Renewable Natural Resources)

Assistant Professors Robert Itami (Renewable Natural Resources), Chet Ross (Family and Consumer Resources)

The Committee on Environment and Behavior functions to coordinate and further develop study of the relationship between physical settings and human activities. This multidisciplinary group of teachers and researchers will assist students in the integration of such specialization into their chosen fields. Undergraduate students interested in combining an environment and behavior emphasis into majors such as psychology, architecture, landscape architecture, interior design, geography, renewable natural resources, political science, and water resources administration should consult their department advisers and appropriate members of the Committee on Environment and Behavior.

While no graduate major is offered, the Committee does offer a doctoral minor. A minimum of fifteen units from environment and behavior courses approved by the Committee is required.

Current information on studies in environment and behavior can be obtained from the Chairperson, Committee on Environment and Behavior, Department of Psychology. Courses identified as having content which deals specifically with environment and behavior include: Arch. 287, 429, 474, 497i; Art. 434; Geog. 275, 360, 407, 561, 563; Idis. 596u; L.Ar. 533, 595a; N.R.R. 470; Pol. 481; Psyc. 371, 428, 52a-521b; R.N.R. 595c.
EXERCISE AND SPORT SCIENCES

Professors Charles M. Tipton, Head, Anne E. Atwater, Timothy G. Lohman, Donna Mae Miller, Frederick B. Roby, Mary P. Roby
Associate Professors Boyd B. Baker, Gary D. Delforge, Patricia C. Fairchild, Kathryn R. E. Russell, Darrell G. Simko, Jean M. Williams
Assistant Professors Victor A. Convertino, Roger M. Enoka

The Department of Exercise and Sport Sciences is concerned with advancing the body of knowledge in the exercise and sport sciences and preparing professionals for careers in teaching, coaching, research, and applied exercise science. The department offers programs leading to the Master of Science and Master of Arts 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 wishing to specialize in exercise physiology at the doctoral level should consult the Committee on Animal Physiology (see that entry elsewhere in this catalog).

Prerequisites for admission to full graduate standing include a minimum of 15 semester units of specified undergraduate work in physical education or exercise and sport sciences and 9 units in approved allied disciplines. Applicants are required to submit scores on the aptitude test of the Graduate Record Examination and to arrange to have three letters of recommendation, from persons in a position to evaluate the applicant's potential as a graduate student, sent directly to the Graduate Program Director, Department of Exercise and Sport Sciences.

Study programs for both the Master of Science and Master of Arts degrees are individually planned, in consultation with an adviser, around a principal area of interest. At least 20 units must be completed in exercise and sport sciences, but students are encouraged to take work in related fields as well if it is directed toward research interests. A thesis is optional, but a student who chooses to write one may earn as many as 6 units for its preparation. In the thesis option, the student must complete a minimum of 30 units of approved graduate work. Students who do not elect to write a thesis must complete 32 units of approved graduate work. Excellent research facilities are available.

422. Aging and Leisure (3) GC I Investigation of psychological, sociological and physiological characteristics of aging populations; exploration of services for the aging; and analysis of problems and opportunities related to leisure and recreation. Advanced degree credit available for nonmajors only.

485. Sport in Contemporary Society (3) GC I Study of contemporary sport from the perspectives of its personal, social, cultural, economic and educational dimensions. Miller


496. Proseminar b. Analysis of Data in Human Motion Studies (1) GC II Atwater

515. Philosophy of Physical Education and Sport (3) I Designed to help the student examine philosophic foundations, to explore the philosophic process, and to analyze, formulate, and apply principles as guides to action. P, twelve upper-division units of ex.s.s Miller

520. Biomechanics of Human Movement (3) I Analysis of human motion focusing on the mechanical interaction between the human body and the external environment. 2R, 3L. P, 370, Ecol. 159a-159b, twelve upper-division units of ex.s.s. Atwater

525. Motor Learning and Human Performance (3) I Neuropsychological approach to the study of motor skill acquisition and learning variables affecting human potential for physical performance. Fairchild

526. Neural and Perceptual Foundations of Motor Learning and Performance (3) I Examines the neural basis of motor behavior and the role and influence of perceptual modalities in motor learning and sports performance; topics include sensory coding, perceptual processing and motor control. Russell


535. Issues and Trends In Physical Education and Sport (3) II Designed to aid the student in identifying, analyzing, and evaluating recent developments and basic issues in physical education and sport. P; twelve upper-division units of ex.s.s. Miller.

536. Administration of Sports Programs (3) II 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. Miller.

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, 373, 374, Math. 117e. Wilmore.

550. Advanced Exercise Physiology Laboratory (3) II Experiments designed to demonstrate basic concepts of physiological responses to exercise with emphasis on development of skills in laboratory instrumentation and techniques of research. Convertino/Roby/Wilmore.


565. Physical Activity and Coronary Heart Disease (3) II The etiology and pathophysiology of coronary heart disease (CHD); primary and secondary risk factors; diagnosis of CHD; role of exercise in primary and secondary prevention. Field trips. P, 530. Wilmore.

570. Research Design in Exercise and Sport Sciences (3) I II 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.


582. Anatomical Basis of Sport Injuries (2) I Comprehensive survey of bones, ligaments, muscles, nerves, and vessels of the trunk and upper and lower extremities, with emphasis on their relationship to sport injuries. 1R, 3L. P, CR 580. Hillman.

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.


586. Physical Education and the Law (3) S 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.
Management of Athletic Injuries (3) S Principles of injury recognition and initial management of sports injuries for the coach, physical education teacher, and other athlete health care personnel. Credit is allowed for this course or 580, but not for both. P, 377. De/forge

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.

Practicum
b. Exercise Technician/Exercise Prescription (2) I I II P, 374, 394d. Wilmore

Seminar
a. Contemporary Problems in Athletics (3) S Simko

Colloquium
a. Physiological Adaptations to Training (2) [ Rpt./I] I II P, 530.
b. Environmental Stress and Performance (2) [ Rpt./I] I II P, 530.
c. Cardiovascular Dynamics (2) [ Rpt./I] I II P, 530.
d. Exercise Metabolism (2) [ Rpt./I] I II P, 530.

FAMILY AND CONSUMER RESOURCES

Professors Robert R. Rice, Director, Arthur W. Avery, Victor A. Christopherson, Kathryn L. Hatch, Jean Ruley Kearn, Amy Jean Knorr (Emerita), Doris E. Manning (Emerita), Naomi A. Reich, Carl A. Ridley, George B. Sproles, Mary Adele Wood (Emerita)

Associate Professors Kitty L. Abraham, Roger M. Kramer, Leanne K. Lamke, Mary H. Marion, Joel Rudd

Assistant Professors Oscar A. Blazquez, Donna R. Iams, Maureen E. Kelly, Elizabeth L. Kendall, Molly Longstreth, Chester J. Ross, Mari S. Wilhelm

The School of Family and Consumer Resources offers programs leading to the Master of Science degree with majors in family and consumer resources and home economics education. For the Master of Science degree with a major in family and consumer resources, concentrations are available in child development and family relations; clothing, textiles and interior design; consumer studies and home management; and home economics education. The school also offers programs leading to the Master of Home Economics Education degree with a major in home economics education and, in cooperation with the College of Education, the Master of Education degree with a major in family and consumer resources. For information concerning these degrees see Requirements for Master's Degrees/Master of Home Economics Education and Master of Education elsewhere in this catalog.

All applicants are required to submit scores on the aptitude test of the Graduate Record Examination. Additional admission requirements, if any, are given in the notes under each division below.

Requirements to be included in the graduate study program of each student are 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. Special degree requirements, if any, are given in the notes under each division below. Opportunities to participate in current research programs, such as those at the Agricultural Experiment Station, are available.

Divisions

CHILD DEVELOPMENT AND FAMILY RELATIONS — For the Master of Science degree with a major in family and consumer resources, concentrations are available in (1) human development, which provides training in scientific theory and research across the individual lifespan and family life cycle, as well as the opportunity to gain practicum experience in adult development; and (2) interpersonal relationships, which provides training in personal development and interpersonal competence. Students are required to complete 36 units, including four to six units for the thesis or two units for the master's report.
CLOTHING, TEXTILES, AND INTERIOR DESIGN — For the Master of Science degree with a major in family and consumer resources, a concentration is available in clothing, textiles, and interior design. Students are required to complete 34 units including four to six units for the thesis. This program prepares students for employment in teaching at the secondary-school, community-college, or university level; for promotional and educational or testing and research positions with industrial and commercial companies; or for design and development of furniture and accessories.

HOME ECONOMICS EDUCATION/CONSUMER STUDIES — 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 levels; for teaching at secondary, community-college, or university levels; for supervision at local and state levels; or for educational positions in business.

For the Master of Science degree with a major in family and consumer resources, concentrations are available in family economics, consumer studies and home management, consumer economics, and consumer education. Because of the interdisciplinary nature of the program, allied subjects such as economics, education, management, sociology, and other fields of family and consumer resources may be selected to give the desired emphasis. These programs prepare students for career opportunities in college and university teaching, the Cooperative Extension Service, business, and research.

NUTRITION AND FOOD SCIENCE — See Nutrition and Food Science elsewhere in this catalog.

Family And Consumer Resources

465. Women In International Development (3) GC I 1985-86 (Identical with Anth. 465)

696. Seminar
z. Family and Consumer Resources (1 to 3) [ Rpt./1] II

Child Development and Family Relations

Professor Christopherson, Acting Chairperson of the Division

407. Problems in Child Development (3) GC II 1986-87 Special child-rearing contexts in contemporary society; poverty, minority group membership, social change, and special developmental considerations.

413. Issues in Aging (3) GC II Introductory course in gerontology, with emphasis upon contemporary issues. (Identical with Gero. 413)

417. Advanced Human Development and Relations (3) GC II Behavioral science approaches to interpersonal competence within various societal contexts. P, 117.

427. Problems in Marriage and the Family (3) GC II Identification and analysis of major problem areas in marriage and the family, including economic, sexual, role conflict, emotional disorders, and childrearing.

447. Advanced Child Development (3) GC I In-depth examination of various dimensions of human growth and development. P, 223; 6 units of psyc.

457. Bio-Social Determinants of Socialization (3) GC II Bio-social factors related to socialization and the influence of various subcultures and contexts upon child-rearing practices. P, 223; 6 units of child dev. or soc. or psyc. (Identical with Soc. 457)

487. Readings in Family Relations (3) GC II Critical analysis of selected studies and research. P, 137, or 337, or Soc. 321.

500. Life Span Development (3) II (Identical with Ed.P. 500 )

502. Advanced Adolescent Development (3) II (Identical with Ed.P. 502 )

507a-507b. Research Methods in Social Science (3-3) I II 507a: Problem selection, literature review, research design, data analysis, and other related topics, leading to the development of a research prospectus. 507b: Introduction to computer usage in social sci.; critical review of thesis writing by faculty and peers, including literature review, problem formulation, and research design.

517. Program Development and Evaluation in Micro-level Human Services (3) I Comprehensive review of human and family intervention projects and the procedures involved in developing, implementing, and evaluating these projects. All-day field trips. P, 507b.

547. Theories of Human and Family Development (3) I Analysis and integration of the major theories of individual and family development within a social context; evaluation of theoretical formulations in selected content areas of human relations and individual growth. P, 9 units of child dev., family relations, psyc. or soc. (Identical with Ed.P. 547 )

557. Methods in Marital Therapy (3) I Theories and principles of counseling for premarital, marital, and group counseling situations. (Identical with Coun. 557 and Rhab. 557 )

573. Family Development (3) I Internal development of families over the life cycle, with emphasis on family goals, structure and functioning in the context of American society. P, 223, Soc. 100, or Psyc. 101.

607. Topics in Child Development and Family Relations. (1 to 3) [ Rpt./1 ] GC III Variable content: cognitive development, biological theories of development, role theory, middle childhood, and others.

637. Trends in Human Relations (3) I Philosophy, content, and resources for understanding, teaching and working in the field of human relations.

**Clothing, Textiles, and Interior Design**

Professor Hatch, Chairperson of the Division

**Clothing and Textiles**


444. Dimensions of Clothing Behavior (3) GC II Analysis of psychological, social, cultural, historical, economic and aesthetic dimensions of clothing reported in literature. P, 145, Soc. 100, Psyc. 101, Econ. 201a.

445. Clothing for Special Needs (3) GC I Clothing and accessories for special needs; based upon research.

454. New Developments in the Textile Field (3) GC I Fabric finishes, new fiber development, textured yarns, knits, and fabric use and care problems. P, 284R.

464. Aspects of Clothing Design (3) GC I Rpt./9 units] II Projects in the analysis and manipulation of design media to produce garments to meet selected needs and populations. 1R, 6L. P, 145, 344.

484. Textile Analysis (3) GC II 1985-86 Physical and chemical testing, dyes, microscopic analysis and use of textile testing equipment for fabric analysis. 1R, 6L. P, 454.

**Interior Design**


485. Ethics and Practice for Interior Design (3) GC II Readings in the interior fields, with emphasis on individual professionalism. P, 375.
Home Economics Education/Consumer Studies

Associate Professor Rudd, Chairperson of the Division

Consumer Studies

416. Management of Family Resources (3) GC I II Resources available to families and the use of these resources to obtain family goals. P, Econ. 100a.

436. Economics of Aging (3) GC II Economic issues as they affect the aging individual, family and society; economic demographics, consumer problems, and retirement financial planning. (Identical with Gero. 436)

446. The Consumer and the Market (3) GC I II Consumer problems in the American economy under existing market conditions. P, Econ. 100a.

486. Family Economics (3) GC I Analysis of the family as a consumer-decision-making unit within the larger economic system. P, Econ. 201b.


Home Economics Education

409. Occupational Home Economics Programs (3) GC II Purposes and methods of teaching home economics-related occupations, with emphasis on cooperative home economics vocational education. P, S.Ed. 338g; CR H.E.E. 308 and 389 or teaching experience.

428. Home Economics Education in Business, Government and Human Services (3) GC I Theory and practice of educational methods in non-formal settings in positions in business, government and human services. 2R, 3L. Not open to h.e.c.e.d. majors.

448. Extension Program Planning and Evaluation (3) GC II Bases and procedures for program planning, implementation and evaluation in non-formal education programs such as the Cooperative Extension Service. Examination of issues and trends, observation and individual projects. P, A.Ed. 438, and F.C.R. 428 or A.Ed. 439. (Identical with A.Ed. 448)

497. Workshop r. * Public Relations in Extension (1 to 2) [ Rpt./2] GC (Identical with A.Ed. 497r, which is home)

538. Philosophy and Principles of Extension Education (3) I (Identical with A.Ed. 538)

539. Extension Education Methods (3) II (Identical with A.Ed. 539)

597. Workshop a. * Extension Communication (1 to 2) [ Rpt./2] (Identical with A.Ed. 597a, which is home)
   c. * Extension Credibility and Accountability (1 to 2) [ Rpt./2] (Identical with A.Ed. 597c, which is home)
   d. * Extension Supervision and Administration (1 to 3) [ Rpt./2] (Identical with A.Ed. 597d, which is home)
   g. * Microcomputers-Extension (1 to 2) [ Rpt./2] (Identical with A.Ed. 597g, which is home)
   h. * Family Development through Home Economic Programs (1 to 2)
   t. Principles of Extension Training (1 to 3) I (Identical with A.Ed. 597t, which is home)
   u. Evaluation in Extension Education (1 to 3) I (Identical with A.Ed. 597u, which is home)
   v. Volunteer Staff Development in Extension (3) I 2R, 3L. (Identical with A.Ed. 597v)
   x. Administration of Extension Programs (1 to 3) I (Identical with A.Ed. 597x, which is home)

*Offered only through the Cooperative Extension Service Winter School.

609. Supervision in Vocational Education and Extension (3) I Theory, principles and techniques of supervision in vocational and extension education.

610. Investigation and Studies in Home Economics (3) I Study and analysis of research literature, methods, techniques, and procedures for conducting investigations, selecting and developing plans for research problems.

618. Evaluation in Home Economics Education (3) II Application of theory to the selection and construction of evaluation instruments, their use and interpretation in home economics programs.
Curriculum Theory in Home Economics (3) | Theoretical bases and processes of curriculum building in home economics; current issues in home economics education.

FAMILY ECONOMICS AND HOME MANAGEMENT
(See Family and Consumer Resources)

FAMILY RELATIONS
(See Family and Consumer Resources)

FINANCE AND REAL ESTATE

Professors Gerald O. Bierwag, Willard T. Carleton, Nestor R. Roos, James E. Wert
Associate Professors Eric H. Sorensen, Head, Erich K. Bleck, John T. Emery
Assistant Professors Edward H. Robbins, John D. Schatzberg, Howard S. Stern, Gerry Suchanek

The department offers programs leading to the Master of Science degree with a major in finance. Concentrations are available in finance or real estate. The department also participates in the programs leading to the Master of Business Administration and the Doctor of Philosophy degrees with a major in business administration. For information concerning these degrees see Requirements for Master's Degrees/Master of Business Administration and the headnotes 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 sixtieth 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.


421. Investments (3) GC I II Operation and analysis of the stock, bond, and commodity markets; theory and practice in construction and management of investment alternatives. P, 311.

422. Securities Analysis (3) GC I II Current practices and techniques of evaluating common stocks, bonds, stock options and warrants. P, 421.

431. Financial Intermediaries (3) GC I II Financial markets and institutions; effects of economic conditions and government policy on financial institutions, the flow of funds, and interest rates; term structure of interest rates; financial institution management. P, 311, Econ. 330.

453. Risk Management (3) GC I II Analysis of a logical and systematic approach to uncertainty regarding loss; the identification, analysis, and evaluation of risk and the selection of the most advantageous method of treating it. P, Acct. 210, Econ. 201b.

455. Safety Management (3) GC I Definition of functional requirements of a safety program, management's responsibilities, relationship to insurance; the effect on business of the Occupational Safety and Health Act of 1970 and similar state laws.


465. Advanced Real Estate Appraisal (3) GC II Valuation of income-producing property; the capitalization process, discounted cash flow, concepts of investment analysis. P, 361, 362.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Prerequisites</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>177</td>
<td>471. Policy Formulation and the Finance Function (3) GC I II</td>
<td>Integrative course utilizing the case study approach and focusing on the financial impact of marketing and production strategies.</td>
<td>P, 412, M.A.P. 305, 373, Mktg. 361</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>486. Fundamentals of Industrial Hygiene (3) GC I</td>
<td>Identical with O.S.H. 486</td>
<td></td>
<td>3</td>
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<tr>
<td>177</td>
<td>487. Advanced Industrial Hygiene and Safety (3) GC II</td>
<td>Identical with O.S.H. 487</td>
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<td>3</td>
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<tr>
<td>177</td>
<td>511. Business Finance (3) I II</td>
<td>Integration of the basic principles and theory of business finance, with emphasis on analytical financial management of the firm. Students with credit in 412 should take 512. Open only to students admitted to a BPA graduate program.</td>
<td>P, Acct. 550</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>512. Advanced Corporation Finance (3) II</td>
<td>Financial theory applied to capital structure; investment decisions; corporate valuation; and corporate financial policies.</td>
<td>P, 412 or 511</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>513. Theory of Finance (3) I</td>
<td>Theoretical models pertaining to financial decisions.</td>
<td>P, 412 or 511</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>521. Portfolio Management (3) I</td>
<td>Portfolio theory and applications; equity markets, fixed income, and option markets; risk analysis and investment strategies.</td>
<td>P, 421</td>
<td>3</td>
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<tr>
<td>177</td>
<td>522. Advanced Securities Analysis (3) II</td>
<td>Examination of securities risk, return, and price behavior in competitive markets.</td>
<td>P, 421 or 521</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>531. Money and Capital Markets (3) I</td>
<td>Analysis of the theoretical and practical problems facing individuals and financial institutions managing money and fixed-income portfolios.</td>
<td>P, 421 or 431</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>532. Financial Futures and Options (3) II</td>
<td>Design and trading of interest rate futures and options. Examination of their use in hedging, speculating, arbitraging, and their regulation.</td>
<td>P, 421 or 521</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>555. Advanced Safety Management (3) II</td>
<td>Relating safety management to modern motivation theories; coordinating control of environment and behavior; interaction of unions, business, government, and other societal institutions.</td>
<td>P, 455</td>
<td>3</td>
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<tr>
<td>177</td>
<td>556. Safety Law (3) II</td>
<td>History of law; tort and contract law; court procedure and trial; administrative law; worker's compensation, O.S.H.A., and C.P.S.C. law and cases; safety professional's responsibilities.</td>
<td>P, 555</td>
<td>3</td>
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<tr>
<td>177</td>
<td>557. Safety and Institutional Policy (3) S</td>
<td>Occupational safety problems; society's organization of safety; early legislation; successes and failures of early safety efforts; consumerism; institutions bearing on safety problems.</td>
<td>P, 555</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>561. Advanced Subjects in Real Estate (3) I</td>
<td>Syndication, feasibility studies, tax-free exchanges, and advanced appraising.</td>
<td>P, 361</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>601. Economic Decision Making Under Uncertainty (3) II</td>
<td>Applied economics relating to uncertainty in markets, information, and choice.</td>
<td>P, Econ. 501a</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>610a-610b. Financial Market Theory (3 - 3)</td>
<td>Information theory and market equilibrium theory: asymmetric information, signalling, adverse selection, optimal contracting, rational expectations, arbitrage pricing theory.</td>
<td>P, Econ. 501a-501b</td>
<td>3</td>
</tr>
<tr>
<td>177</td>
<td>620a-620b. Theoretical and Empirical Models (3 - 3)</td>
<td>Financial models and empirical testing: asset pricing models, tests of optimal financial decision making.</td>
<td>P, 512, 513</td>
<td>3</td>
</tr>
</tbody>
</table>

**Seminar**
- a. Investment Analysis (1 to 3) I II
- b. Financial Markets (1 to 3) [ Rpt./1 ] I II
- c. Corporation Finance (1 to 3) [ Rpt./1 ] I II
- d. Capital Budgeting (1 to 3) I II
- e. Research Methods (1 to 3) [ Rpt./1 ] I II

**FOOD SCIENCE**
*(See Nutrition and Food Science)*

**FOOD SERVICE MANAGEMENT**
*(See Nutrition and Food Science)*

**FOUNDATIONS OF EDUCATION**
*(See Educational Foundations and Administration)*
FRENCH AND ITALIAN

Professors Guido Capponi (Emeritus), Frank M. Chambers (Emeritus), Jean-Jacques Demorest, Loyal Gryting (Emeritus), Charles I. Rosenberg
Associate Professors Edward G. Brown, Acting Head, Jonathan Beck, Ingeborg M. Kohn, Henri Servin, Gianni Spera, Ronnie H. Terpening

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 and in Italian. The department also participates in the offering of the M.A. with a major in Romance languages through the Committee on Romance Languages. For information, see Romance Languages elsewhere in this catalog.

The department cooperates with the Arizona Center for Medieval and Renaissance Studies.

Admission to graduate programs in French requires the completion of a bachelor degree with a major in French. Applicants must submit scores on the aptitude and advanced French tests 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 coursework. 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 coursework 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


403a-403b. Literature of the 16th Century (3-3) GC 1985-86 403a: Early Renaissance, Reformation, Rabelais, the Pleiade. 403b: The Humanists, Montaigne, D'Aubigne, the drama. P, 201b.


414. Teaching of Modern Languages (3) GC II (Identical with S.Ed. 414)

415a-415b. Stylistics (3-3) GC Principles of stylistics, with exercises in literary translation and original writing. P, 375b.

422. Introduction to Romance Philology (3) GC I 1986-87 (Identical with Span. 422)
FRENCH AND ITALIAN

430a-430b. French Civilization (3-3) GC Historical, social, economic, literary, and artistic elements in the development of the French nation. P, 201b.


451. Literature of the Fantastique (3) GC II 1986-87 Study of aspects of the supernatural, the unexpected, the unexplainable in French literature; analysis of dominant themes and important authors of the 18th, 19th, and 20th centuries. P, 201b.

452. French Literature of Quebec (3) GC II 1986-87 Comprehensive study of the most significant literary expression in Quebec. P, 201b.


470. Advanced Grammar and Usage (3) GC II Structural analysis of spoken and written French, with emphasis on structural patterns and attention to contrasts with Engl. Grad. students will do additional work in composition and stylistics. P, 201b.

472. French Phonetics (2) GC 11 1985-86 Description, analysis, and practice in the larger elements of articulatory phonetics; designed for teaching majors and minors. P, 372.

510. Materials and Methods of Research (2) I 1985-86 Problems and methods of advanced research in French language and literature. Use of specialized library resources and computerized data bases. Style and presentation conventions for preparation of scholarly research.

511. Approaches to French Literature (3) II 1985-86 Methods of criticism and techniques of literary analysis.


557. Rousseau (3) II 1986-87 Rousseau’s political thought; his ideas concerning education; The Confessions; the beginning of Romanticism.

558. Realism and Naturalism in the Novel (3) I 1985-86 Flaubert, Zola, Maupassant, etc.

559. Contemporary Theatre (3) II 1986-87 Theatre from 1950 to the present time; Ionesco, Beckett, Genet, Arrabal, Obaldia, Tardieu, Dubillard, etc.


579. Problems of Teaching College French (1 to 3) I Emphasis on the problems encountered in teaching lower-division college courses.

696. Seminar
   a. Romance Philology (3) I II
e. 17th Century (3) I II
   b. Topics in French Literature (3) [ Rpt./2] I II
   c. Old French Literature (3) I II
   d. 16th Century (3) I II
   f. 18th Century (3) I II
   g. 18th Century (3) I II
   h. 20th Century (3) I II

Italian

400a-400b-400c. Survey of Italian Literature (3-3-3) GC 400a: The Middle Ages and early Renaissance. 400b: The Renaissance, 17th and 18th centuries. 400c: The 19th and 20th centuries. P, 201b or consult dept. before enrolling.

405a-405b. Advanced Composition and Conversation (3-3) GC P, 201b.

408a-408b. The Italian Novel (3-3) GC P, 201b.

420a-420b. Italian Civilization. (3-3) GC Historical, geographical, social, and artistic aspects of the development of the culture of Italy. P, 201b. 420a is not prerequisite to 420b.
180 DEPARTMENTS AND COURSES OF INSTRUCTION

422. Introduction to Romance Philology (3) GC I 1986-87 (Identical with Span. 422)
430a-430b. Literature of the Renaissance (3-3) GC P, 201b.
435a-435b. La Divina Commedia (3-3) GC P, 201b.
696. Seminar
   a. Italian Literature (3) [ Rpt.] I II

GENERAL BIOLOGY
(See Ecology and Evolutionary Biology)

GENETICS

Committee on Genetics (Graduate)

Professors William P. Bemis (Emeritus, Plant Sciences), Harris Bernstein (Microbiology and Immunology), John R. Davis (Pathology), John E. Endrizzi (Plant Sciences), Robert M. Harris (Emeritus), Ecology and Evolutionary Biology), William B. Heed (Ecology and Evolutionary Biology), Frank R. H. Katterman (Plant Sciences), Robert G. McDaniel (Plant Sciences), Neil H. Mendelson (Molecular and Cellular Biology), David W. Mount (Molecular and Cellular Biology) Robert T. Ramage (Plant Sciences), Donald Ray (Animal Sciences), Nobuyoshi Shimizu (Molecular and Cellular Biology)

Associate Professors Oscar G. Ward (Ecology and Evolutionary Biology), Chairperson, Richard E. Michod (Ecology and Evolutionary Biology), Jeffrey Trent (Research, Internal Medicine), Stephen Zegura (Anthropology)

Assistant Professor Sue DeNise (Animal Sciences)

The Committee on Genetics, comprising geneticists from various departments, offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in genetics. Concentrations are available in animal and plant genetics; cytogenetics; and ecological, human, microbial, molecular, physiological, population; and statistical genetics.

Admission generally depends upon the completion of a bachelor's degree with undergraduate credit in general biology (introductory botany, microbiology, and zoology), four units each of ecology, genetics, physiology, and developmental biology, six units of organic chemistry, eight units of introductory physics, and mathematics through integral calculus and introductory statistics.

The master's degree program is designed to provide the student with a broad background in genetics and cognate sciences. The course of study for the M.S. degree requires a minimum of 30 units of graduate work including 15 units from certain of the courses below (see Committee). A thesis is normally required, but the requirement may be waived after consideration of the student's proposed graduate program and professional objectives. Doctoral programs will include, in addition to the requirements for the master's degree, those courses deemed necessary to proper training in the major and minor areas as determined by the student's guidance committee.

Related Courses

Refer to the appropriate department for course descriptions. Courses which are applicable to the program are Agri. 539, 540; 666; Bioc. 460, 565a-565b, 568a-568b; M.C.B. 410a-410b, M.C.B. 428R, 428L, 562, 612; Chem. 480a-480b; Ecol. 522, Ecol. 523, 525, 526; Micr. 570, 580; N.F.S. 617, 620; P.I.S. 516, 627, 632, 634, 635.

520. History of Genetics (1) I 1986-87 Experiments and discoveries which have led to the present state of knowledge in the various areas of genetics. P, Ecol. 320 or 321.

595. Colloquium
   a. Genetics (1) [ Rpt.] I II
Applications and Techniques of 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. 620) Ward

Recent Advances in Genetics (2) I Recent advances in the field of genetics. (Identical with Ecol. 670)

GEOPHYSICAL AND REGIONAL DEVELOPMENT

Professors Lay James Gibson, Head, Terence Burke, Melvin E. Hecht (Emeritus), Lawrence D. Mann, Leland R. Pederson, Richard W. Reeves, Thomas F. Saarinen, Dan Stanislawski (Emeritus), Norman Williams, Jr., Andrew W. Wilson (Emeritus)
Associate Professors D. Robert Altschul, Gordon F. Mulligan
Assistant Professor David A. Plane

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.

Geography

All applicants are required to submit scores on the aptitude section 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 passing a qualifying examination during the first semester of resident graduate study.

All students working toward the Master of Arts degree are required to complete 485, 500, 557 and 589 during the first year in residence. In addition, students will normally enroll in 696f each semester they are in residence, up to a maximum of 9 units. The 30 units required for the degree must include at least 18 units of geography at the 500 or 600 level; 696f may be used to meet this requirement. The remainder of the program is selected, with the approval of an adviser, from geography and supporting disciplines. Courses may include geography courses at the 400, 500, or 600 level or courses outside the department. Students may, with the consent of an adviser, elect to write a thesis. 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.

No thesis is required for the Master of Education degree program. For further information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

The professional M.S. with a major in planning which focuses on development planning for urban and rural regions is offered through the department. For further information see Planning elsewhere in this catalog.

Students working toward the Doctor of Philosophy degree must, in addition to the requirements for the Master of Arts degree, complete a minimum of 18 units in geography (exclusive of the dissertation) of which no fewer than 15 units must be at the 500-level or above. Doctoral students are required to enroll in 796a each semester they are in residence, up to a maximum of 9 units. Students must also achieve high-level competence in two fields of concentration, one topical and one regional, and will ordinarily complete six units of work in each. Topical concentrations available are behavioral, cultural, economic, historical, physical, and urban geography, and regional development. Regional concentrations available are Anglo-America (or United States), arid lands, and Latin America. Doctoral language requirements may be met by one of three options: a reading knowledge of French or German and one other approved language; high proficiency in the use of one approved language; or a reading knowledge of an approved language and completion of an eleven-unit sequence in statistics/computer science to be prescribed by the departmental faculty. The minor or
minors must be complementary to the student's program of specialization. The dissertation should incorporate aspects of both the topical and regional concentrations chosen. More detailed information may be obtained by writing to the head of the department.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
<th>General Education</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>401</td>
<td>Introduction to Water Resources Management</td>
<td>3</td>
<td>GC II</td>
<td>(Identical with W.R.A. 401)</td>
</tr>
<tr>
<td>407</td>
<td>The American Landscape</td>
<td>3</td>
<td>GC II</td>
<td>Origin and character of the visual aspects of places viewed individually and regionally; changes in habitat, vernacular structures, landscaping, townscape, countrysides and special features. Field trips.</td>
</tr>
<tr>
<td>408</td>
<td>Arizona and the Southwest</td>
<td>3</td>
<td>GC I II</td>
<td>The changing character of the land and man's occupation of it, with emphasis on Arizona; historically and problem oriented. Field trip.</td>
</tr>
<tr>
<td>411</td>
<td>Middle America</td>
<td>3</td>
<td>GC II</td>
<td>Land, man, and culture in the major natural and cultural regions of Mexico, Central America, and West Indies. Pederson</td>
</tr>
<tr>
<td>412</td>
<td>South America</td>
<td>3</td>
<td>GC I</td>
<td>Physical and cultural bases of South America's geographic patterns, with emphasis on human settlement and problems of resource development. Pederson</td>
</tr>
<tr>
<td>413</td>
<td>Africa</td>
<td>3</td>
<td>GC II</td>
<td>Physical and human bases of regional contrasts, with emphasis on tropical environmental systems and changing patterns of resource utilization. Altschul</td>
</tr>
<tr>
<td>414</td>
<td>Rural Area Development</td>
<td>3</td>
<td>GC I</td>
<td>(Identical with A.Ec. 414)</td>
</tr>
<tr>
<td>453</td>
<td>Industrial Location Analysis</td>
<td>3</td>
<td>GC II</td>
<td>Geographic distribution of industrial location; location factors and case studies; scale and the modern corporation; geographic inequalities and public policy. (Identical with Ping. 453) Mulligan</td>
</tr>
<tr>
<td>456</td>
<td>Urban Geography</td>
<td>3</td>
<td>GC I</td>
<td>Analysis and modeling of the spatial organization of cities; concepts of settlement patterns and processes; social and economic interpretations of the modern city. Field trip. (Identical with Ping. 456) Mulligan</td>
</tr>
<tr>
<td>457</td>
<td>Statistical Techniques in Geography and Planning</td>
<td>3</td>
<td>GC I</td>
<td>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 Ping. 457) Plane/Silvers</td>
</tr>
<tr>
<td>461</td>
<td>Population and Resources</td>
<td>3</td>
<td>GC I</td>
<td>Estimates of present and potential world population; distribution and methods of conserving important resources. Field trips. (Identical with Ping. 456 and W.R.A. 461)</td>
</tr>
<tr>
<td>463</td>
<td>Physical Aspects of Arid Lands</td>
<td>3</td>
<td>GC II</td>
<td>Landforms, climate, hydrology, soils, vegetation, and animal life of deserts, with particular emphasis on the interaction of these phenomena in southern Arizona. Field trips. Altschul/Reeves</td>
</tr>
<tr>
<td>464</td>
<td>The Arid and Semiarid Lands</td>
<td>3</td>
<td>GC I</td>
<td>Past, present and future of settlement and resource utilization in the world's arid lands; spatial interrelationships of environmental, demographic, socioeconomic and political systems. Altschul</td>
</tr>
<tr>
<td>469</td>
<td>Geography of the Middle East</td>
<td>3</td>
<td>GC I</td>
<td>(Identical with Or.S. 469)</td>
</tr>
<tr>
<td>471</td>
<td>Problems in Regional Development</td>
<td>3</td>
<td>GC I II</td>
<td>Regional inventories and methods of analysis; development problems, policies and strategies; generation, implementation, and evaluation of development of programs; case studies. (Identical with A.Ec. 471 and Ping. 471) Gibson</td>
</tr>
<tr>
<td>481</td>
<td>Computer Cartography</td>
<td>3</td>
<td>GC II</td>
<td>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 Ping. 481) Reeves</td>
</tr>
<tr>
<td>483</td>
<td>Geographic Applications of Remote Sensing</td>
<td>3</td>
<td>GC II</td>
<td>Use of aircraft and satellite imagery for monitoring and analyzing landforms, soils, vegetation and land use, with the focus on problems of land-use planning, resource management and related topics. 2R, 3L. Field trip. P, two units of remote sensing or equivalent experience. (Identical with Ping. 483)</td>
</tr>
<tr>
<td>485</td>
<td>Geography Summer Field Camp</td>
<td>6</td>
<td>GC S</td>
<td>Physical and cultural problems in geography studied at first hand. Fee, $300. P, six units of geog. Gibson/Reeves</td>
</tr>
<tr>
<td>500</td>
<td>Current Geographical Research</td>
<td>3</td>
<td></td>
<td>Major trends and issues in human and physical geography. Field trips.</td>
</tr>
<tr>
<td>510</td>
<td>Development of Regional Planning</td>
<td>3</td>
<td></td>
<td>Survey of the historical development of the planning profession; the evolution of American planning as a response to urbanization. Open to majors only. Credit allowed for this course or 300, but not for both. (Identical with Ping. 510)</td>
</tr>
</tbody>
</table>
511. **Metropolitan and Regional Planning** (3) I 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 Ping. 511) *Mann*

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 Ping. 556) *Mulligan*

557. **Spatial Analysis** (3) II Formal analysis and modeling of spatial structures and processes; conceptual evaluation of point patterns, networks, surfaces and interaction. P. 457. (Identical with Ping. 557) *Reeves*

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 Ping. 561) *Saarinen*

562. **Paleoecology and Man** (3) I (Identical with Geos. 562)

563. **Perception of Environment** (3) I II Examination of interdisciplinary research on environmental perception; consideration of social and behavioral variables at all scales of environmental perception and planning. (Identical with Ping. 563) *Saarinen*

569. **History of Geographic Thought** (3) I History of geographic philosophy and methodology. P. fifteen units of geog. *Pederson*

596. **Seminar**
   a. Economic Geography (3) I II
   b. Cultural Geography (3) I II
   c. Physical Geography (3) I II
   d. Historical Geography (3) I II
   e. Area Study (3) I II
   f. Doctoral Research Seminar (3) [Rpt./3] I II
   u. Interdisciplinary Environment-Behavior-Design (3) I (Identical with Idis. 596u, which is home)

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 Ping. 605) *Mann*

608. **Planning Law** (3) II Land-use controls, the law of zoning, exclusionary zoning, restrictive covenants, comprehensive plan, environmental protection, eminent domain, nuisance. (Identical with Ping. 608) *Williams*

609. **Policy Problems in Structure and Change** (3) II (Identical with M.A.P. 609)

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 Ping. 611)

659. **Growth Controls** (3) II Current legal and planning 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 Law 659 and Ping. 659)

696. **Seminar**
   f. Master’s Research Seminar (3) [Rpt./9 units] I II
   o. The General Plan (3) [Rpt./6 units] I II (Identical with Ping. 696o)
   p. Alternative Urban Futures (3) [Rpt./6 units] I II (Identical with Ping. 696p)

796. **Seminar**
   a. Doctoral Research Seminar (3) [Rpt./3] I II

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**GEOLOGICAL ENGINEERING**

(See Mining and Geological Engineering)

**GEOLOGY**

(See Geosciences)
DEPARTMENTS AND COURSES OF INSTRUCTION

GEOSCIENCES

Professors George H. Davis, Head, John W. Anthony (Emeritus), Victor R. Baker, William B. Bull, Robert F. Butler, Clement G. Chase, Peter J. Coney, Paul E. Damon, Jeffrey S. Dean (Laboratory of Tree-Ring Research), William R. Dickinson, Charles W. Ferguson (Laboratory of Tree-Ring Research), Harold C. Fritts (Laboratory of Tree-Ring Research), Laurence M. Gould (Emeritus), John M. Guilbert, C. Vance Haynes (Anthropology), Gerhard O. W. Kremp (Emeritus), Valmore C. LaMarche (Laboratory of Tree-Ring Research), Everett H. Lindsay, Paul S. Martin, Evans B. Mayo (Emeritus), Edgar J. McCullough, Jr., Bartholomew S. Nagy, Denis L. Norton, Joseph F. Schreiber, Jr., Terah L. Smiley (Emeritus), Marvin A. Stokes (Laboratory of Tree-Ring Research), John S. Sumner (Emeritus), Spencer R. Titey, Jame R. Wait (Electrical and Computer Engineering)

Associate Professors Karl W. Flessa, Jibamitra Ganguly, Austin Long, Timothy P. Loomis, H. J. Melosh (Planetary Sciences), P. Jonathan Patchett, Randall M. Richardson, Charles W. Stockton (Laboratory of Tree-Ring Research)

Assistant Professors Owen K. Davis, Christopher J. Eastoe, Joaquin Ruiz, Frank Telewski (Laboratory of Tree-Ring Research), Terry C. Wallace

The department 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 bachelor’s degree with a major in geosciences or in an allied discipline. All applicants must submit directly to the department their scores on the general and subject tests of the Graduate Record Examination, and provide three letters of recommendation and a personal resume including a statement of proposed academic and research activities.

Degrees

MASTER OF SCIENCE — Designed to train students committed to working in industry, in local, state or federal government programs, or as teachers in a junior college setting. 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.

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 master’s degree or a bachelor’s degree may be accepted into the Ph.D. program.

Students working toward an advanced degree in geosciences should concentrate in one or more of the following curriculum options:

Economic Geology — Ore deposits petrology; hydrothermal ore deposits; fluid inclusion studies; sulfur isotope analysis; alteration petrology/geochemistry; plate tectonics and ore deposits; mathematical theory of magma-hydrothermal systems; dynamic models of intrusion; volcanicogenic ore systems.

Geophysics — Seismology; inverse theory; potential fields; plate-dynamics; geoelectromagnetism (a joint effort with the Department of Electrical and Computer Engineering); paleomagnetism; electrical geophysics.

Mineralogy-Petrology-Geochemistry — Morphology and structure of crystals; crystal chemistry; experimental petrology; thermodynamics and kinetics of the mineralogical evolution of rocks; thermal evolution of of rocks; crystal growth in igneous and metamorphic processes; trace element geochemistry; isotope geochemistry; geochemistry of the mantle; composition of the earth's core; organic geochemistry and history of early life.
Planetary Geology — A concentration through the Departments of Geosciences and Planetary Sciences. Geomorphology of planetary surfaces; geochemical evolution of planetary bodies; geochemistry/cosmochemistry of meteorites; stress modeling in planetary bodies; organic geochemistry of the solar system; planetary geophysics; cratering.

Quaternary-Paleoenvironmental Studies — Paleocology; paleoclimatology; environmental geology; palynology; dendrochronology; radiocarbon dating; stable isotope geochemistry; quaternary geology-stratigraphy.

Stratigraphy-Paleontology — Sedimentary petrology; depositional sedimentary environments; basin analysis; stratigraphy; biostratigraphy; invertebrate and vertebrate paleontology; paleocology and evolution.

Tectonics — Structural geology; regional tectonics; tectonic geomorphology; sedimentary tectonics; tectonophysics; geochronology; tectonic implications of paleomagnetism.

400. Methods in Geochronology (3) GC I Concepts, methods and problems in the measurement and calibration of geologic time. Lindsay

401. Environmental Education (3) GC II Nature of ecosystems; relationships of people and their environment; major conservation problems; discussion of proposed solutions; the experiential approach. Field trips, including three days in Sonoran wilderness. (Identical with Ed.F.A. 401 )

403. Introduction to the Solar System (3) GC I (Identical with Pty.S. 403 )

407. Photogeology (3) GC II (Identical with G.En. 407 )

409. Introductory Vertebrate Paleontology (3) GC I Survey of the vertebrate fossil record, with emphasis on morphological characters relating the major groups of vertebrates. P, 101b, 102b or Ecol. 102. Lindsay

410. Mammalian Phylogeny and Evolution (3) GC II 1986-87 A study of the mammalian fossil record, with emphasis on taxonomy and morphological evolution of selected mammal orders. 2R, 3L. Field trips. P, 409. Lindsay

414. Sedimentary Geology (3) GC I Sedimentary processes and depositional systems; sedimentary textures and structures; nonmarine, transitional, and marine deposition. 2R, 3L. Field trips. P, 107 or 109. Dickinson


419. Physics of the Earth (3) GC I Introduction to plate tectonics and to the structure and dynamics of the Earth using seismology, heat flow, gravity and magnetics. P, Math. 254, Phys. 121. (Identical with Pty.S. 419 ) Richardson/Chase

420. Geophysical Exploration: Potential Field Methods (4) GC I Principles of gravity, magnetic, and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources. 3R, 2L. P, Math. 254. (Identical with G.En. 420 ) Chase

422. Petroleum Geology (3) GC I Origin, migration, chemistry, and accumulation of petroleum; reservoir mechanics, types of traps; recovery of petroleum; oil shales and tar sands. 2R, 3L. Nagy

424. Paleomagnetism: Principles and Applications (3) GC II Physical basis for remanent magnetism in rocks, techniques of sample collection, measurements, and statistical treatment; review of polarity time scale, apparent polar wander, plate tectonics. P, Phys. 103b or 116. Butler


435. Hydrogeology (3) GC II (Identical with Hydr. 435 )

438. Biogeography (3) GC II (Identical with Ecol. 438)


440. Topics in Geodynamics (3) [Rpt./1] GC II Large scale tectonic problems approached through geophysical combined with geological analysis, both in regional tectonic context. P, 20 units of geology, incl. 221, and 3 units geophysics.

441. Geomorphology (4) GC I Concepts of landform development, with emphasis on fluvial processes and environmental applications. 3R, 3L. Field trips. P, 101a, 102a. Bull


443. Principles of Geochemistry I (3) GC I Equilibrium and kinetic chemical processes producing soils, natural waters, and chemical sediments. P, 101a, 102a; Chem. 103b, 104b. (Identical with Hydr. 457) Long

444. Principles of Geochemistry II (3) GC II Nuclear systematics and thermodynamics with applications in high temperature geochemistry. P, 101a, 102a; Chem. 103b, 104b.

445. Introduction to Quaternary Ecology (3) GC I Methods and theories used in reconstructing vegetation and climate. Palynology, packrat middens, dendroclimatology. Field trip. (Identical with Anth. 462)

446. Introduction to Dendrochronology (3-3) GC Survey of dendrochronological theory and methods. Applications to archaeological, geological, and biological dating problems and paleo-environmental reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 464a-464b and WS.M. 464a-464b) Dean

447. Introduction to Paleoecology (3) GC II Palaeontologic approaches to the reconstruction of ancient environments, populations and communities. Evolution of communities through geologic time. 2R, 3L. Field trips. P, 225, 302. Flessa

448. Geology and the Urban Environment (3) GC I 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 Ping. 474)

449. Cenozoic Mammalian Faunas (3) GC II 1985-86 Continental Cenozoic stratigraphy and mammalian biochronology of North America and other continents. 2R, 3L. Field trips. P, 409. Lindsay

450. Petrology (3-3) Earth composition; spatial and temporal distribution of rock types; application of physicochemical principles to magmatic and metamorphic processes. P, 405, Chem. 480a or CR. Loomis/Ganguly

512. Petrology of Sandstones (3) I Origin, deposition, and diagenesis of sandstones and other terrigenous sedimentary rocks; classification in hand specimens, detrital grains, and thin sections. 2R, 3L. Field trips. P, 405. Schreiber

513. Late Quaternary Geology (3) I How geologic processes affect environment; how late Pleistocene and Holocene paleoenvironments and geochronology have been determined from stratigraphic records and geomorphology at key localities and archaeological sites. Field trips. P, 101b, 102b. (Identical with Anth. 514) Haynes

520. Meteorites (3) II 1986-87 (Identical with Pty.S. 520)

521. Detailed Structural Analysis (3) II Geometric, kinematic, and dynamic analysis of deformational structures; stereographic and computer treatment of fabric data; experimental deformation; structural analysis in field; report writing. All day field trips every Friday. P, 412. G. Davis
525. Regional Tectonics (3) I Methods of tectonic regionalization and integration based on litho-tectonic assemblages, tectono-stratigraphic terranes, and regional structural analysis. Discussion of types of orogenic systems, plate regimens and their kinematics, economic aspects regional tectonics. Coney

526. Regional Tectonics of the North American Cordillera (3) II Tectonic evolution of the North American Cordillera viewed through the model of plate and accretionary tectonics. Coney

527. Advanced Geochemistry (3) I Isotope and trace element geochemistry applied to problems in the origin of the Earth, magmas and mineral deposits, and the evolution of the crust-mantle system. P, 458. (Identical with Pty.S. 527)

528. Nuclear Geology (3) II 1986-87 Nuclear phenomena applied to the solution of geologic problems, with emphasis on radio isotope dating and isotope petrology. (Identical with Pty.S. 528) Demon

535. Aquifer Mechanics (3) I (Identical with Hydr. 535)

536. Development of Groundwater Resources (3) II (Identical with Hydr. 536)

541. Soil Genesis (3) II (Identical with S.W. 541)

542. Ore Deposit Petrology (3) II 1986-87 Orthomagmatic, porphyry base metal, skarn, and leached capping lithologic-mineralogic studies by petrographic microscope, electron probe, and advanced techniques. 1R, 6L. P, 425 or CR, 546a. Gullbert/Titley

543. Mathematical Theory of Magma-Hydrothermal Systems (3) I Dynamics and chronology of natural systems are reconstructed using mathematical systems and computer models to represent the redistribution of thermal and mechanical energy around magma chambers. Norton

544. Theory of Ore Deposition (3) II Application of physical chemistry and allied laboratory techniques to the problems of hydrothermal ore formation. P, Chem. 480a. Eastoe

545. Geochemical Processes in Magma-Hydrothermal Systems (3) II Migration of chemical components in natural fluid-rock systems are analyzed using the geochemical theory that represents irreversible, equilibrium and advection mass transfer. Norton

546a-546b. Advanced Ore Deposit Geology (4-4) Geology characteristics and origin of ore deposits in igneous, sedimentary, and metamorphic rocks. Labs. include field trips, analytical techniques, problem solving. 2R, 6L. P, 303, 405, Chem. 480a or CR. Titley/Guilbert

554. Evolution of Planetary Surfaces (3) II 1986-87 (Identical with Pty.S. 554)


561. Paleoindian Origins (3) II (Identical with Anth. 561)

562. Paleoecology and Man (3) I Changing environments of the last 100,000 years; migration, extinction, and domestication in prehistoric time. 2R, 3L. Field trips. (Identical with Geog. 562) Martin

564. Isotope Hydrology (3) I Theory and application of light stable and cosmogenic isotopes to hydrological and paleoenvironmental problems. Radiometric dating of ground water. (Identical with Hydr. 564) Long

565. Isotope Geology (3) II Theory and application of light stable isotopes to petrological, ore deposition, and geothermal problems. Long


567. Inverse Problems in Geophysics (3) I 1986-87 Linear inverse theory, including geeralized and stochastic methods, with application to geophysical problems in seismology, gravity, geomagnetics and other areas. P, Math. 422b. (Identical with Pty.S. 567) Richardson

568. Advanced Seismology (3) II 1985-86 Computational techniques in seismology. The application of synthetic seismograms to model source processes and complex structure. P, 432; Math. 422b. Wallace
571. Constitution and Evolution of the Terrestrial Planets (3) 1985-86 (Identical with Pty.S. 571)

579. Introduction to Quaternary Macrofossil Analysis (4) [ Rpt./1] II Literature and techniques of identification of plant remains including leaves, seeds, and wood of gymnosperms and angiosperms. 2R, 6L. Field Trips. P, Ecol. 472 O. Davis


581. Quaternary Palynology (4) II Theory and application of pollen to geology, biology, archaeology, and paleoecology; definition of information pollen sample record; experience in pollen extraction and identification. 3R, 4L. (Identical with Anth. 581)

584. Sedimentary Basins (3) II Sedimentologic, stratigraphic, structural, subsidence, thermal, and diagenetic evolution of sedimentary basins in relation to plate tectonic setting. 2R, 3L. Dickinson

585. Petrology of Carbonate Rocks (3) II Origin, depositional environments, and diagenesis of carbonate and associated chemical and biochemical sedimentary rocks. 2R, 3L. Field trips. P, 405. Schreiber

596. Seminar
a. Petrography-Petrology (1 to 4) I II
b. Structural Geology (1 to 4) I II
c. Mineral Deposits (1 to 4) I II
d. Petroleum Geology (1 to 4) I II
e. Tectonics (1 to 4) I II
f. Mineralogy-Crystallography (1 to 4) I II
g. Vertebrate Paleontology (1 to 4) I II
h. Paleontology (1 to 4) I II
i. Paleocology-Paleoenvironments (1 to 4) I II
j. Geomorphology (1 to 4) I II
k. Geophysics (1 to 4) I II
l. Geomathematics (1 to 4) I II
m. Sedimentology (1 to 4) I II
n. Stratigraphy (1 to 4) I II
o. Regional Tectonics (1 to 4) I II
p. Hydrogeology (1 to 3) [ Rpt./2] I II (Identical with Hydr. 596p, which is home)
q. General Geochronology (1 to 4) I II
r. Quaternary Geochronology (1 to 4) I II (Identical with Anth. 596r)
s. Sedimentary Petrography (1 to 4) I II
t. Organic Geochemistry (1 to 4) I II
u. Inorganic Geochemistry (1 to 4) I II
v. Dendrochronology (1 to 4) I II
w. Palynology (1 to 4) I II
x. Paleobotany (1 to 4) I II
y. History of Earth Sciences (1 to 4) I II
z. Geophysical Data Handling (1 to 4) I II


651. Tectonic and Climatic Geomorphology (3) II 1986-87 Effects of tectonic movements and climatic changes on geomorphic processes, landforms, and soils; paleoclimatic and earthquake-hazards interpretations. 2R, 3L. Field trips (includes spring break field trip). Bull


GERMAN

Professors Renate A. Schulz, Acting Head, Jean R. Beck (Emeritus), David H. Chisholm, Max Dufner, David J. Woloshin (Emeritus)

Associate Professors Dennis I. Greene, Richard C. Helt, Babette Luz (Emerita), Roland Richter
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 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, 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-601b is required of all master's candidates; 479a is required of all teaching assistants. No thesis is required. The student must pass both a written and an oral comprehensive examination. Prior to this examination each student must either have passed 475a or 475b 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.

400a-400b. History of German Literature (3-3) GC Historical survey of German literary development from the beginning to the modern period; lectures in Ger., alternating with conferences in Engl. P; six units of upper-division Ger. 400a is not prerequisite to 400b. Greene

405. History of the English Language (3) GC I II (Identical with Engl. 405)

410a-410b. Cultural Development of Germany (3-3) GC Social, political, religious, and artistic elements entering into the growth and development of Germany; lectures in English. 410a is not prerequisite to 410b. Dufner/Richter

426b. German Art (3) GC II (Identical with Art. 426b)

469a-469b. Germanic Folklore: An Introduction to Nonliterary Forms (3-3) GC Tales, balladry, folk speech, customs and lore of the Germanic people. Readings and lectures in Engl. Readings in Ger. for Ger. majors. (Identical with Engl. 469a-469b) 469a is not prerequisite to 469b.

475a-475b. Advanced Grammar and Stylistics (3-3) GC Practical training in written Ger. through the study of the more complex refinements of German grammar and style, as found in representative documents. P; 315b. 475a is not prerequisite to 475b. Richter

479a-479b. Problems of Teaching German (3-3) GC 479a: Modern methods of language teaching with emphasis on the particular problems presented by Ger. 479b: Emphasis on applied linguistics. 479a is not prerequisite to 479b. Schulz

496. Proseminar
a. Translation (3) [Rpt./2] GC I II P; 315b.

502a-502b. German Lyric Verse from the 16th to the 20th Century (3-3) GC Introduction to the principles and forms of poetry; analysis and interpretation of outstanding examples of German lyric verse from the 16th through the 20th century. P, 302a, 302b, 400a or 400b. 502a is not prerequisite to 502b. Chisholm

503. Eighteenth-Century German Literature (3) II 1985-86 Klopstock, Lessing, Wieland, Goethe, Schiller, Hoelderlin and other authors. P; six units of upper-division Ger. Dufner

505a-505b. Nineteenth-Century German Literature (3-3) GC 1986-87 A survey. P; six units of upper-division Ger. 505a is not prerequisite to 505b. Richter/Helt

507. Goethe's Faust (3) II 1986-87 A close reading of the poem and an introduction to some of the critical secondary literature. P; six units of upper-division Ger. Dufner

509a-509b. Modern German Literature (3-3) CG 1985-86 Class and collateral reading, lectures and reports, partly in Ger. P; six units of upper-division Ger. 509a is not prerequisite to 509b. Helt

511a-511b. Middle High German Literature (3-3) 1986-87 Brief study of Middle High German grammar; selective readings from representative literary works of the period. P; 302b, 315b.

520a-520b. History of the German Language (3-3) GC 1985-86 Introduction to Germanic philology; the development of the German language from its roots in the Indo-European language family to New High German. P; eight units of upper-division Ger. (Identical with Engl. 520a-520b)
190 DEPARTMENTS AND COURSES OF INSTRUCTION

525. Beowulf (3) II (Identical with Engl. 525, which is home)
527a. Studies in Medieval Language and Literature (3) (Identical with Engl. 527a)
594. Practicum
   a. Translation (2 to 5) [Rpt./3] P, 496a or departmental proficiency exam.
596. Seminar
   i. Germanic Linguistics (3) [Rpt.] II (Identical with Engl. 596i, which is home)
597. Workshop
   a. Translation (3) [Rpt./3] I II P, competency at third-yr. undergrad. level or pass departmental placement test.
601a-601b. Materials and Methods of Research (2-2) Survey of the tools of literary and linguistic research and methods of dealing with research. 601b concentrates on principles of literary criticism. 601a is not prerequisite to 601b.
Chisholm
696. Seminar
   a. Literature (2 to 4) I II
   b. Linguistics (2 to 4) I II (Identical with Engl. 696b)
   c. Folklore (2 to 4) I II (Identical with Engl. 696c)
   d. Pedagogy (2 to 4) I II
   e. Translation (2 to 4) I II

GERONTOLOGY

Committee on Gerontology

Professors William A. Stini (Anthropology), Chairman, Daniel R. Boone (Speech and Hearing Sciences), John T. Boyer (Internal Medicine), Herbert E. Carter (Emeritus, Biochemistry), Victor A. Christopherson (Family and Consumer Resources) Dorothy I. Marquart (Psychology), Roy G. Spece, Jr. (Law), Charles W. Weber (Nutrition and Food Science), Jack H. Wilmore (Exercise and Sport Sciences)
Associate Professors J. Lyle Bootman (Pharmacy Practice), Theodore H. Koff (Management and Policy), Jessie V. Pergrin (Nursing)

Because of its multidisciplinary nature, study in gerontology is located in a number of departments. The Committee 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 Committee 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 both degree candidates and unclassified students to pursue gerontological study in the Gerontology Certificate Program which offers formal recognition through an eighteen-unit structured course of 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 the major field through course work, research, thesis and dissertation. This most commonly occurs in the Departments of Counseling and Guidance, Management and Policy, Psychology, Rehabilitation, Speech and Hearing Sciences, the School of Family and Consumer Resources, and the Colleges of Nursing and Pharmacy. In addition, graduate work with a strong gerontological focus is available in long term care administration (M.P.A.) and gerontological nursing (M.S.). Courses in other departments identified as having content which deals specifically with elderly and aging processes include: Coun. 570; Law 656; Nurs. 589; C.T. 445; N.F.S. 538; Ph.Pr. 549; Psy. 421, 428; M.A.P. 595d, 662; Rhab. 455; Sp.H. 554.

Further information on gerontology study and Committee programs can be obtained from the Coordinator, Committee on Gerontology, Anthropology 214.
The School of Health-Related Professions, an integral part of the Arizona Health Sciences Center, presently offers the Master of Education degree with a major in health education.

**MASTER OF EDUCATION** — For the major in health education, applicants must have bachelor’s degrees from approved colleges or universities, with a cumulative grade-point average of 2.50 on all work attempted.

The major requires a minimum of 32 units, including 17 units of health education (from Hlth. 430, 431, 432, 433, 434, 435, 436, 437, 440, 475, 496a, 499, 599, and 699 ) and twelve units of education courses, including Ed.F.A. 603. A thesis is not required. The candidate must pass a final examination in both health education and education. Depending upon the student’s background, electives may be taken with the approval of the student’s major adviser.

Specializations are available in secondary education, higher education, or special education. For further information on courses required for each of these specializations, contact the School of Health-Related Professions.
192 DEPARTMENTS AND COURSES OF INSTRUCTION

549. Interdisciplinary Approaches to Health Care of the Aged (3) S (Identical with Ph.Pr. 549)

564. Principles and Methods of Epidemiology (3) II Study of chronic diseases and mortality; indices of health, factor-disease associations; measures of disease frequency, study design, data analysis, and interpretation of results; discussion of basic biostatistical procedures.

Health Education

430. Critical Analysis of Health Education (3) GC I Analysis and evaluation of curriculum, new teaching techniques and administrative trends in health science education; critical discussion of issues, research publications, and current periodicals in the area of health education. P, 180 or 181.

431. Field Work in Health Education (3) GC I On the job participation and observation in health programs of public and voluntary health organizations. Open to health education majors only.

432. Organization and Administration of School Health Education (3) GC I Principles and techniques for organizing and administering school health programs; discussion of curriculum, facilities, personnel, school health legislation, administrative problems.

433. International Health Problems (3) GC I Interprets the major health problems not only of the developed and emerging nations, but also the situations in underdeveloped countries; includes assistance programs by international health groups.

434. Sex Education (3) GC II Critical analysis of the current philosophy, principles, programs, problems, trends and basic issues in sex education on the elementary, junior high and high school levels.

435. Safety Education and Accident Prevention (3) GC II Analysis of accident prevention programs in schools, colleges, communities, and industry, with emphasis on specific protective measures pertaining to athletics, physical education, recreation, highway safety, and vocational training.

436. Traffic Safety Education (3) GC I, II Principles of accident prevention and traffic survival education, with emphasis on the certification of secondary school teachers preparing to teach driver education and training.

437. Contemporary Community Health Problems (3) GC II Analysis of the concept of community health services, human ecology, and conservation of human resources, with emphasis on modern miasmas such as air, water, and noise pollution; sociological problems of alcohol, alcoholism, and drug abuse. P, 178.

440. Survey of Health Education Literature (3) GC II Examination of health education literature from ancient societies to present, including an analysis of current health literature from various professional, voluntary, public and international health organizations.

475. Alcohol Abuse and Alcoholism (1) GC S Review of the nature and ramifications of alcohol problems, as well as analysis of physical, psychological and social implications.

496. Proseminar
   a. Tobacco, Alcohol, and Narcotics (3) GC I, II

Medical Technology

481a-481b. Clinical Laboratory: Hematology (6-4) GC [Rpt./1] S Basic hematology and hematological procedures including cell structure and function, inherited and acquired anomalies, hemostasis, cell enumeration and differentiation, cytogenetics. P, committee permission.

482a-482b. Clinical Laboratory: Immunology and Immunohematology (4-4) GC [Rpt./1] Serological methods used in the clinical laboratory and interpretation of results; blood banking procedures. P, committee permission.

483a-483b. Clinical Laboratory: Chemistry (6-6) GC [Rpt./1] Fundamental concepts of clinical laboratory chemistry including pathophysiology and clinical correlations. P, committee permission.

484a-484b. Clinical Laboratory: Microbiology and Parasitology (6-6) GC [Rpt./1] Clinical laboratory techniques to safely and accurately culture or isolate and identify pathogenic organisms; physiological consequences of parasitism and the role of the laboratory in treatment. P, committee permission.
485. **Clinical Laboratory: Sciences** (2) GC [ Rpt./1] I II Basic principles of instrumentation, laboratory mathematics, biostatistics, quality control, toxicology, nuclear medicine, laboratory management and laboratory safety. P, committee permission

**Occupational Safety and Health**

402. **Industrial Hygiene Instrumentation and Analysis** (3) GC II Introduction to field sampling instruments, concepts, quality control, and statistical analysis, with emphasis on instrument selection and calibration. 2R, 3L. P, 486a, Chem. 322, 323, and CR Chem. 324.

410. **Physical Exposures** (3) GC II Recognition, evaluation, and control of physical exposures, including radiation, noise, vibration, and heat stress. Student is required to recognize potential exposures, use correct instrumentation to collect and evaluate data, and develop controls. 2R, 3L. P, 486a.

412. **Hazardous Materials** (3) GC II Recognition, evaluation, and control of exposure to environmental and industrial air contaminants. Students must submit a paper detailing hazards associated with a particular chemical. P, 486a.

486. **Fundamentals of Industrial Hygiene** (3) GC 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 C.E. 486 and Fin. 486 and Tox. 486)

487. **Advanced Industrial Hygiene and Safety** (3) GC II An in-depth coverage of the industrial hygiene and safety professions emphasizing the principles of contaminant generation and behavior, the design of industrial hygiene/safety programs, and survey of industrial plants. P, 486. (Identical with C.E. 487, Fin. 487 and Tox. 487)

488. **Applied Industrial Safety** (3) GC II Thorough study of technical safety topics such as fire technology, systems safety, manual materials handling; selected topics in construction and manufacturing safety. P, 486b.

495. **Colloquium**

**HEALTH SERVICES ADMINISTRATION**

(see Management and Policy)

**HEBREW**

(see Oriental Studies)

**HIGHER EDUCATION**

**Center for the Study of Higher Education**

Professors Larry L. Leslie, Director, Don L. Bowen (Management and Policy), Clifton F. Conrad, Vine Deloria, Jr. (Political Science), Lawrence O. Nelson (Educational Foundations and Administration), F. Robert Paulsen (Educational Foundations and Administration)

Associate Professor Donal M. Sacken (Educational Foundations and Administration)

The Center for the Study of Higher Education offers programs leading to the Master of Arts, Master of Education, Doctor of Philosophy, and Doctor of Education degrees with a major in higher education. Doctoral programs are designed for persons planning to serve in professional and administrative positions in institutions of higher education. Minor programs also are available for doctoral students with majors in other fields and are particularly appropriate for those planning to teach in institutions of higher education. Limited specializations may be planned in various areas, such as academic administration, student
personnel administration, finance and business management, community college administration, or research in higher education. Master of Education degree programs may be designed to meet the requirements for the Arizona Community College Teaching Certificate (Type I) or for entry-level administrative service in institutions of higher education (Type II). All applicants for advanced degree programs are required to submit: personal data form, statement of educational goals, and three letters of recommendation, at least two of which should reflect past academic work. The usual College of Education requirement of at least fifteen units of undergraduate work in education will be waived for persons planning to earn certification in community college teaching and for others seeking graduate degrees with course work or experience appropriate to their professional goals. An interview with a member of the faculty is required before registration for course work. Preference will be given to degree applicants who apply for admission as follows: for summer session I or II or fall semester, by April 1; for spring semester, by October 15. Following admission, individual programs of study are planned on the basis of professional goals and the past training and experience of the student. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research.

Degrees

**MASTER'S DEGREES** — An undergraduate grade-point average of at least 2.75 is required for admission to master’s degree programs. Applicants with grade-point averages of at least 2.50 may be admitted on a provisional basis.

**DOCTORS' DEGREES** — Applicants must submit satisfactory scores on the Miller Analogies Test or the verbal and quantitative tests of the Graduate Record Examination. A master's degree or equivalent study, with an undergraduate grade-point average of 2.75 and a graduate grade-point average of 3.33 or better, are generally required for admission. Applicants should have completed a minimum of one year of successful full-time professional staff or administrative experience in an institution or agency of higher education, or must complete an internship as part of the graduate program.

Requirements for the Doctor of Philosophy with a major in higher education include proficiency in three areas: basic research methods, basic statistics, and other special competencies needed for the dissertation and for future professional roles. These requirements must be met before taking the oral preliminary examination. Proficiency in basic research methods is met by successful completion of Ed.F.A. 603, and in statistics by completing Ed.P. 640. Proficiency in the third area is met by one of the following: six units of advanced research methods, statistics, or a combination, twelve units in a second foreign language, or six units in another approved competency area. In addition, 796a is required of all doctoral students.

Doctoral degree programs are designed by the student and the adviser, in consultation with the Advisory Committee. All students should participate in a variety of professional activities in addition to completion of the approved program of course work.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as a result of the review.

**497. Workshop**

a. Fiscal Stress in Higher Education (1) [ Rpt./1] GC I

**560. 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.
602. Foundations of Student Personnel Work in Higher Education (3) I Orientation to student personnel work in colleges and universities; interdisciplinary foundations; professional aspects; integrated lab. experience in selected campus settings. (Identical with Coun. 602)

607. The College Student (3) I History and characteristics of the college student; interactions with campus environmental influences; developmental and normative trends; major research findings. (Identical with Coun. 607)

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.

610. History and Philosophy of Higher Education (3) I Historical backgrounds and philosophical bases for higher education from early beginnings, through the medieval period, the Renaissance and the Enlightenment, to the modern day.

615. Adult Education and Development (3) I Analysis of adult education and development; characteristics of adult learners and behavior; and the consideration of life-long learning. (Identical with Ed.P. 615)

617. Student Personnel Services in Higher Education (3) II Student personnel services; purposes; procedures; representative programs; current trends. (Identical with Coun. 617)

620. Curriculum in Higher Education (3) II Early classical curriculum; development and administration of general education and professional studies; modern curriculum developments and innovations.

621. Teaching in Higher Education (3) II Planning, organizing, and evaluating learning experiences for mature students.

625. Administration of Academic Programs (3) I Administration of all phases of the academic area, including curriculum, personnel, facilities, financing, planning, evaluation and accreditation, with attention to newer delivery systems, nontraditional education, contract plans and potential future developments. Field trips. P, 601 or 609.

640. Institutional Research and Planning (3) I Development of institutional research programs for short-term and long-term planning; input and output measures.

641. Computer Applications in Higher Education (3) II Administrative uses of computers in higher education institutions; teaching with computers; computer as a research tool; information networks; public service applications. Field trips.

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. Field trips.

651. Higher Education Business Management (3) II Budget planning and execution; systems of resource allocation; personnel management; physical plant planning and construction; information systems and use in management.

675. The Law and American Education (3) I (Identical with Ed.F.A. 675)

677. Higher Education and the Law (3) II Critical court decisions, past and present, affecting higher education; increasing role of the courts in decision making and policy development. Field trips. P, 601, 609, 610, 620 or 650. (Identical with Ed.F.A. 677)

693. Internship
   a. Administrative Internship (3 to 9) I II
   b. Instructional Internship (3 to 6) I II Biweekly seminar meetings required. P, bachelor's degree plus twelve units, 621 (for students without a subject-field methods course), 615, 560.

695. Colloquium
   a. Community College Developments (1 to 3) I 1985-86 Field trips.
   c. Public Policy Issues in Higher Education (1) [ Rpt. ] I II
   d. Community Colleges in the Future (1) [ Rpt. ] I II

696. Seminar
   a. Community College Administration (3) I II Field trips.
   d. Governance and Coordination (3) I II Field trips.
   e. Topics in Higher Education (1) [ Rpt./2 ] I II.
   f. Topics in Community College Education (1) [ Rpt./2 ] I II.
   g. Topics in Higher Education Administration (1) [ Rpt./2 ] I II.
DEPARTMENTS AND COURSES OF INSTRUCTION

697. Workshop
   a. Collective Negotiations (1 to 3) I II (Identical with Ed.F.A. 697a, which is home)

796. Seminar
   a. Research in Higher Education Administration (3) I II.

HINDI
(See Oriental Studies)

HISTORY

Professors Donald Weinstein, Head, Gail Bernstein (Oriental Studies), Ludwig W. Adamec (Oriental Studies), Herman E. Bateman (Emeritus), Robert P. Browder, Paul A. Carter, Leonard Dinnerstein, James Donohoe, Robert M. Gimello (Oriental Studies), Harwood Hinton, Ursula Lamb (Emeritus), Murdo MacLeod, John V. Mering, Michael C. Meyer, Roger L. Nichols, Heiko A. Oberman, J. Gregory Oswald, Thomas W. Parker (Emeritus), Michael Schaller, William H. Sewell, Boyd Shafer (Emeritus), Jing-shen Tao (Oriental Studies), Robert Vignery


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 Master of Arts 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 and three letters of recommendation. Doctoral applicants must have completed the equivalent of the master's degree and are required to submit scores on the aptitude tests of the Graduate Record Examination and three letters of recommendation. Doctoral applicants must also submit evidence of proficiency in one foreign language. Unless the master's degree was earned at the University of Arizona, students will be required to take a qualifying examination during the first year of doctoral studies.

Degrees

MASTER OF ARTS — At least 24 units must be completed in history including nine units (at least three of which are at the 500 level) in each of two of the following areas: Ancient; Europe, 300-1648; Europe, 1648-1945; Latin America; United States; Applied History; Women's History. The student who elects to submit a thesis (six units) is required to complete at least twelve units at the 500 level in history other than independent study. 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 500 level in history other than independent study. 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 500 level. 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 adviser, each beginning student will select a major field and two special fields of study. One special field may be outside the department. 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. MAJOR FIELDS: Ancient Greece, Ancient Rome, Europe — 300-800, Europe — 800-1300, Europe — 1300-1648, Europe — 1648-1815, Europe — 1815 to the Present, Latin America, United States, Women's History, Comparative History.

401. Ancient Mesopotamia (3) GC I 1986-87 (Identical with Anth. 401)

402. History of Biology (3) GC II Great writings in biology and medicine. (Identical with Ecol. 402)

403a-403b. History of Greece (3-3) GC 403a: From prehistoric times to the outbreak of the Peloponnesian War. 403b: From the outbreak of the Peloponnesian War to the end of the Hellenistic Age. 403a is not prerequisite to 403b. (Identical with Clas. 403a-403b) de Laix

404a-404b. History of Rome (3-3) GC 404a: The Republic to the death of Caesar. 404b: The Empire through the reign of Constantine the Great. 404a is not prerequisite to 404b. (Identical with Clas. 404a-404b) de Laix

405a-405b. Medieval Europe (3-3) GC Major institutions and trends in Europe from the breakup of the Roman World to the 15th century. 405a is not prerequisite to 405b. (Identical with Reli. 405a-405b) Bernstein

406. Medieval England (3) GC I From the Roman conquest to the War of the Roses, with emphasis on political, economic, and cultural developments. Bernstein

407. Intellectual History of Medieval Europe (3) GC II Fusion of the Greco-Roman, Christian, and German traditions and analysis of major medieval cultural and intellectual achievements. (Identical with Reli. 407) Bernstein

408. The Renaissance (3) GC I Social, economic, cultural, and religious history of the 14th and 15th centuries; humanism, artistic revolution, and new world discoveries. (Identical with Reli. 408) Weinstein

409. The Reformation (3) GC II Social, economic, cultural, and religious history of the 16th and early 17th centuries; the Protestant revolt, Catholic Reformation and Counter-Reformation. (Identical with Reli. 409) Oberman

410. History of Hell in Early Europe (3) GC II The concept of punishment after death in Western Europe from the Bible to Dante. Includes the Hebrew, Greco-Roman, Germanic, and Christian traditions. (Identical with Reli. 410) Bernstein

411. European Intellectual History to 1750 (3) GC 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. Donohoe

412. European Intellectual History: 1750 to 20th Century (3) GC 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. Donohoe

413. War and Peace in Europe (3) GC II European background to contemporary international relations from the Congress of Vienna through the outbreak of World War II. Browder

414. Medieval and Early Modern Germany (3) GC I The political, social, economic and cultural history of Germany from the late Middle Ages to about 1800. Donohoe/Rebel

415. Modern Germany (3) GC II The political, social, economic and cultural history of Germany from the period of the French Revolution to the present. Donohoe/Rebel

416. Tudor-Stuart England (3) GC I An intensive study of English history from the accession of Edward IV to the Hanoverian dynasty. (Identical with Reli. 416) Cosgrove

417. History of Modern Britain (3) GC II An intensive study of English history from the accession of George III to the present. Cosgrove

418. France under the Old Regime, 1589-1789 (3) GC I French political development, institutions, and culture from Henry IV to the eve of the French Revolution. Vignery
198 DEPARTMENTS AND COURSES OF INSTRUCTION

419. The French Enlightenment (3) GC I Cultural history of France in the 18th century, with emphasis on the works of the philosophes. Vignery

420. The French Revolution and Napoleon (3) GC II The origins and progress of the Revolution in France. Vignery

421. History of Russia: Early Period (3) GC I Political, socio-economic, and cultural history of Russia in medieval and early modern times. Kellogg

422. History of Russia: Modern Period (3) GC II Political, socio-economic, and cultural history of Russia in the modern era until the Bolshevik Revolution. Kellogg

423. Intellectual History of Russia (3) GC II The historical significance of social, political, and revolutionary thought in 19th- and 20th-century Russia. Oswald

424. The Russian Revolutions (3) GC I The era of reform and revolutions in Russia from 1890 to 1921, culminating in the formation of the Soviet regime. Browder

425. History of the Soviet Union (3) GC I The Bolshevik Revolution and problems of Soviet Russian history from 1917 to the present. Oswald


427. Russian-American Relations: 1781 to the Present (3) GC II Diplomatic, social, economic and cultural relations between Russia and the United States. Browder

428. The Scientific Revolution, 1500-1700 (3) GC II The individuals, theories, and institutions that contributed to the rise of early modern science, in their relation to the intellectual and cultural trends of the period. Lenoir

431. Colonial America (3) GC I The experience and evolving institutions of the North Atlantic colonists from the first landings to the end of the French and Indian War. Marietta

432. The Era of the American Revolution (3) GC II Origins, progress, and character of the struggle against Great Britain; internal political, constitutional, social, and economic developments; the problems of the "Critical Period" and the making of the Constitution. Marietta

433. Jefferson and the New Nation, 1790-1825 (3) GC I The Federalists and the rise of the Republican party; a biographical, economic, political and social history of the early North, South and expanding West. Gaines

434. The Jacksonian Era, 1825-1850 (3) GC II Political, social and economic developments in the United States from the adoption of the Monroe Doctrine through the Mexican War. Gaines/Mering

435. The Coming of the Civil War, U.S. 1845-1861 (3) GC I Political, constitutional, social and economic developments in the U.S. from the Mexican War through the Civil War. (Identical with BI.S. 435) Mering

436. Civil War and Reconstruction, U.S. 1861-1878 (3) GC II Political, constitutional, economic, and military developments in the U.S. and the Confederacy during and after the Civil War. (Identical with BI.S. 436) Mering

437. U.S. 1876-1919 The Gilded Age and Progressive Era (3) GC Examination of economic, social and political developments in years of rapid industrialization from the end of Reconstruction through World War I. Carter

438. U.S. 1918-1945 From World War I through World War II (3) GC Prosperity, Depression and the New Deal in peace and war. Carter/Garcia

440. United States: 1945 to Present (3) GC II American society and the role of the United States in world affairs from the Yalta Conference to the present. Dinnerstein/Schaller

442. History of American Society and Thought: Pre-Civil War (3) GC I American political, religious, cultural and philosophical ideas as expressed in colonial, revolutionary, and pre-Civil War society. Carter

443. History of American Society and Thought Since the Civil War (3) GC II The transformation of American minds since the Civil War as expressed in literary, philosophic, religious, and other cultural forms. Carter

444. History of Arizona (3) GC I The history of Arizona from the entrance of the Spaniards in 1539 to its emergence as a modern state in the Southwest. Hinton

449. History of American Foreign Relations to 1914 (3) GC I Examines the rise of America from a struggling colony to a world class power, including its relations with Europe, Latin America and Asia. Schaller
450. History of American Foreign Relations since 1914 (3) GC 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. Schaller

451. The United States and East Asia: 1840 to the Present (3) GC II 1966-87 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. (Identical with Or.S. 451) Schaller

452. American Ethnic History (3) GC II A history of the various ethnic minorities in America from Colonial times to the present, with emphasis on adjustment, acculturation and degrees of assimilation. (Identical with BLS. 452) Dinnerstein/Garcia

453. History of Women and Work (3) GC I History of women and work in western and non-western nations from prehistoric times to the present. (Identical with W.S. 453) Anderson

454. Feminism: A Comparative History (3) GC II International history of feminism as an ideology and a political movement from the 17th century to the present. (Identical with W.S. 458) Anderson

455. Historical Archaeology (3) GC II (Identical with Anth. 459)

456. History of the Hispanic Borderlands (3) GC II The Spanish and Mexican experience in the Southwest from the 16th century to 1848. (Identical with M.A.S. 460)

457. The Iberian Empires (3) GC II European background to, and results of, Iberian expansion from the 15th through 17th centuries. Spanish colonialism in the New World is contrasted with Portuguese systems in the East. MacLeod

458. Intellectual History of Latin America since 1810 (3) GC II 1986-87 Latin American thought from Independence to the 20th century; major Latin American thinkers and writers, and influences from Europe and the United States. Brubaker

459. Marxism in East Asia (3) GC I (Identical with Or.S. 463)

460. History of Argentina (3) GC I Survey of Argentine history and culture from the colonial era to the present. Guy

461. History of Spain (3) GC I II S History of Spain from remote times to the present; emphasis on the period from 1492, Spain's role in the world and the Spanish Civil War; Spain's cultural contributions. Brubaker

462. History of Brazil (3) GC II Brazil's political, economic, social and intellectual development. Guy

463. Contemporary Latin America (3) GC II Revolution, social change and reaction in Latin America from 1930 to the present. Guy

464. Asia and the West (3) GC I (Identical with Or.S. 468)

465. History of Women in Latin America (3) GC II Women's history in Latin America from the Conquest to the present. (Identical with W.S. 469) Guy

466. Introduction to Indic Civilization (3) GC I (Identical with Or.S. 471)

467. History of Medieval India (3) GC I 1985-86 (Identical with Or.S. 472)

468. History of Modern India and Pakistan: 1750-Present (3) GC II 1985-86 (Identical with Or.S. 473)

469. History of the Middle East (3-3) GC (Identical with Or.S. 477a-477b-477c-477d-477e)

470. Modern Chinese History (3) GC (Identical with Or.S. 476)

471. Social History of China (3) GC (Identical with Or.S. 482)

472. History of Byzantium (3) GC II Political, social, and cultural history of Byzantium from A.D. 325 to 1453, including the Byzantine legacy in Europe and the Middle East. (Identical with Clas. 488) Kellogg

473. Women in East Asia (3) GC I (Identical with Or.S. 489)
495. Colloquium
   a. Revolution in Chinese History (3) GC I II (Identical with Or.S. 495a, which is home)
   b. Studies in Black America (3) GC I II (Identical with Bl.S. 495b)
   c. The Mexican American (3) GC I II (Identical with M.A.S. 495c)
   d. Modern Chinese Frontier Areas (3) GC I 1985-86 (Identical with Or.S. 495d) Hedtke

496. Proseminar
   a. Historical Research and Writing (3) GC I II

595. Colloquium
   Certain colloquia in Oriental studies may be used for hist. grad. credit.
   a. Advanced Studies in United States History (3) I II
   b. Advanced Studies in Latin American History (3) I II
   c. Advanced Studies in European History (3) I II
   d. Applied History (3) I Field trips. (Identical with La.S. 595d)
   e. Advanced Studies in the History of Women (3) I II (Identical with W.S. 595e)
   f. Advanced Studies in Ancient History (3) I Consult department before enrolling. (Identical with Clas. 595f)

596. Seminar
   Certain seminars in Oriental studies may be used for hist. grad. credit.
   a. Colonial U. S. History (3) I II
   b. Nineteenth-Century U. S. History (3) I II
   c. Twentieth-Century U. S. History (3) I II
   d. Ancient History (3) I II
   e. Medieval Europe (3) I II
   f. Early Modern Europe (3) I II
   g. Nineteenth-Century Europe (3) I II
   h. Twentieth-Century Europe (3) I II
   i. Latin America: Modern Period (3) I II
   j. Latin America: Modern Period (3) I II
   k. Historical Writing and Editing (3) I II
   l. History of Science (3) I II

597. Workshop
   a. College Teaching (1) I

HISTORY AND PHILOSOPHY OF SCIENCE

Committee on History and Philosophy of Science (Graduate)

Professors Leon Blitzer (Physics), William A. Longacre (Anthropology)
Associate Professors Henry C. Byerly (Philosophy), Chairperson, Robert M. Harnish (Philosophy), Timothy Lenoir (History) Richard E. Michod (Ecology and Evolutionary Biology)

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 Philosophy 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.

HOME ECONOMICS
(See Family and Consumer Resources)

HYDROLOGY AND WATER RESOURCES

Professors Nathan Buras, Head, Donald R. Davis, Stanley N. Davis, Lucien Duckstein, Daniel D. Evans, Martin M. Fogel (Watershed Management), John W. Harshbarger (Emeritus), Simon Ince, Thomas Maddock, III, Shlomo P. Neuman, Eugene S. Simpson,
Associate Professors Michael D. Bradley, Soroosh Sorooshian.
Assistant Professor Roger C. Bales
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, hydrogeochemistry, ground-water 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. 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. It is recommended that applicants submit scores on the Graduate Record Examination.

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. A thesis based on individual research is required for the master’s degree, and 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, 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** — The program is designed for students with special interest in legal, economic, political, and behavioral aspects of water resource conservation, development, and management. Courses and research provide learning experience in both quantitative and nonquantitative methodologies. Students may concentrate in one or in a combination of these fields but should acquire some proficiency in all aspects of water resources administration and hydrology.

### Hydrology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Group Code</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>405.</td>
<td>Hydrology of Unsaturated Media (3) GC I</td>
<td>3</td>
<td>GC I</td>
<td>P, Phys. 103b, Math. 125b. (Identical with S.W.405 )</td>
</tr>
<tr>
<td>414a-414b.</td>
<td>Field Hydrology (Summer Camp) (3-3) GC S</td>
<td>3-3</td>
<td>GC S</td>
<td>Daily field work. Fee.</td>
</tr>
<tr>
<td>423.</td>
<td>Hydrology (3) GC I (Identical with C.E. 423 )</td>
<td>3</td>
<td>GC I</td>
<td></td>
</tr>
<tr>
<td>457.</td>
<td>Principles of Geochemistry I (3) GC I (Identical with Geos. 457 )</td>
<td>3</td>
<td>GC I</td>
<td></td>
</tr>
<tr>
<td>460.</td>
<td>Watershed Hydrology (3) GC I (Identical with Ws.M. 460 )</td>
<td>3</td>
<td>GC I</td>
<td></td>
</tr>
<tr>
<td>471.</td>
<td>Water Quality Control (3) GC II (Identical with C.E. 471 )</td>
<td>3</td>
<td>GC II</td>
<td></td>
</tr>
<tr>
<td>480.</td>
<td>Hydrologic Systems (3) GC I Major aspects of the hydrologic cycle are studied quantitatively, with emphasis on model construction and simulation. 2R, 3L. Field trips. P, 423 or 460.</td>
<td>3</td>
<td>GC I</td>
<td></td>
</tr>
</tbody>
</table>
202 DEPARTMENTS AND COURSES OF INSTRUCTION

481. **Physical Oceanology and Limnology for Hydrologists** (2) GC II 1985-86 Origin, distribution, and characteristics of oceanic water; advective and convective processes; estuarine and shoreline processes; effect on coastal aquifers; classification and hydrologic regimen of lakes. P, Math. 125b.

502. **Snow Hydrology** (2) I 1986-87 (Identical with Ws.M. 502)

503. **Subsurface Fluid Dynamics** (3) I Kinematics and dynamics of fluids in saturated porous and fractured media; introduction to free surface, unsaturated, and multiphase flows. P, A.M.E. 331a, Math. 422a.

504. **Numerical Methods in Subsurface Hydrology** (4) II Finite difference and finite element methods for subsurface fluid flow and mass or energy transport; applications to aquifers, unsaturated soils, seepage through earth dams, geothermal systems. 3R, 3L. P, Math. 422a.

506. **Water Quality Dynamics** (3) II Chemical and physical methods are used to study the quality of ground and surface waters with emphasis on electrolyte chemistry, heterogeneous processes, colloids, and surface processes including sorption phenomena. Equilibrium and dynamic models of water chemistry. P, Chem. 480a or 350.


536. **Development of Ground-Water Resources** (3) II Analytic techniques to evaluate geohydrologic systems; case histories used to study management of ground- and surface-water resources; planning and design of regional water resource investigations. Field trips. P, 535. (Identical with Geos. 536)

540a-540b. **Advanced Surface Water Hydrology** (3-3) Fluvial dynamics and flood routing; flood hydrology; hydrology of water supply; classical and numerical methods. P, 423.

545. **Advanced Statistical Hydrology** (3) I 1986-87 Advanced application of statistics and probability to hydrology and water resources; multivariate modeling, choice of models and parameters, simulation, Bayesian decision theory. P, 445.

564. **Isotope Hydrology** (3) (Identical with Geos. 564)

565. **Hydrochemistry** (3) II 1985-86 (Identical with S.W.565)

596. **Seminar** p. Hydrogeology (1 to 3) [ Rpt./2] I II (Identical with Geos. 596p)

603. **Well Hydraulics and Pumping Test Analysis** (2) II 1986-87 Flow to wells in aquifers, with emphasis on design and interpretation of pumping tests; confined, unconfined, and leaky aquifer systems; fractured rocks; automatic curve matching. P, 503 or 535, Math. 422a.

605. **Soil Water Dynamics** (3) II 1986-87 (Identical with S.W.605)


695. **Colloquium**
   a. Hydrology (1 to 3) [ Rpt./1] I II
   b. Unsaturated Flow (2 to 3) I II
   c. Regional Hydrologic Analysis (1 to 3) II P, 423, 435.
   d. Desert Hydrology (1 to 3) [ Rpt./2] I II 1986-87
   e. Pollutants in the Hydrologic Environment (1 to 3) I II

Water Resources Administration

401. **Introduction to Water Resources Management** (3) GC II Water resources projects as instruments for implementing socioeconomic policies; the role of behavioral sciences (social, legal, economic, political, and psychological) in planning the development, conservation, and utilization of water resources; environmental influences of water resources projects. (Identical with Geog. 401)
461. Population and Resources (3) GC I (Identical with Geog. 461)
476. Natural Resource Economics (3) GC II (Identical with A.Ec. 476)
480. Forest Policy and Administration (3) GC II (Identical with Ws.M. 480)
481. Environmental Policy (3) GC II (Identical with Pol. 481)

501a-501b. Water Resources Policy and Administration (3-3) Institutional and policy aspects of water resources administration; management, organizational theory, and international problems of water use and development; ground-water management and policy. 501a is not prerequisite to 501b.

525. Water Quality Modeling (3) I (Identical with C.E. 525).
526. Water Quality Management (3) II Optimization and systems analysis techniques used in modeling; current models used in formulation and implementation of water quality policy. P, 525. (Identical with C.E. 526).

544a-544b. Quantitative Methods in Water Resources Administration (3-3) Applications of quantitative methods to water resource management; benefit-cost analysis, and optimization. 544a: Structure and basis of planning process; Principles and Standards. 544b: Operations research methods (linear, quadratic, and dynamic programming). P, FORTRAN, microeconomics, Math. 125a. 544a is not prerequisite to 544b.

556. Finite State Methods in Water Resources Management (3) II 1986-87 Finite state methods; applications to natural resource systems as arise in hydrology, ecology, and earth sciences, including the modeling of interfaces such as socioeconomic processes. P, Math. 254, S.I.E. 170. (Identical with S.I.E. 556)


576a-576b. Advanced Natural Resource Economics (3-3) (Identical with A.Ec. 576a-576b)

643. Water Resources Systems Analysis (3) I Applications of mathematical programming to the analysis of interactions of hydrology, engineering, economics, and socio-institutional environment in regional water resources systems. P, 544b or consult dept. before enrolling.

695. Colloquium
b. Water Resources Administration (1 to 3) [ Rpt./1 ] II

696. Seminar
h. Long-Range Resource Planning (1 to 3) [ Rpt./2 ] I
i. International Water Resource Management (1 to 3) [ Rpt./2 ] I
m. Water Storage Systems (1 to 3) [ Rpt/1 ] II P, consult department before enrolling.

INDUSTRIAL ENGINEERING
(See Systems and Industrial Engineering)

INTERDISCIPLINARY PROGRAMS

The Office of Interdisciplinary Programs is the agency responsible for furthering the development of interdisciplinary activities. The Coordinator of Interdisciplinary Programs works with the Graduate College and with the Vice President for Research in fostering educational and research projects.

In most cases, interdisciplinary courses are listed under a "home" department and crosslisted in a variety of other departments. These appear under the appropriate headings elsewhere in this catalog.

596. Seminar
u. Interdisciplinary Environment-Behavior-Design (3) I (Identical with Arch. 596u, Geog. 596u, L.Ar. 596u, Psyc. 596u, and Ping. 596u).
INTERIOR DESIGN
(See Family and Consumer Resources)

IRRIGATION
(See Soils, Water and Engineering)

ITALIAN
(See French and Italian)

JAPANESE
(See Oriental Studies)

JOURNALISM

Professors Philip Mangelsdorf, Head, Donald W. Carson, Abraham S. Chanin, George W. Ridge, Jr.
Associate Professors Ford N. Burkhart, William F. Greer, James W. Johnson
Assistant Professors C. Bickford Lucas, Jimmy D. Patten, Jacqueline E. Sharkey.

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 two departmental newspapers and to demonstrate a high level of skill in reporting and writing courses. The program of study must include 411, 413, 502, 509, 596a, 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.

403. Advanced Photojournalism (3) GC I II Open to majors only. P, 301, 302.
405. The Study of News (3) GC I II Critical study and problem analysis of the media. Field work may include publication of conclusions.
411. News Features (3) GC I II Writing the basic news feature article; specialized reporting and rewriting techniques. P, 206.
413. Reporting Public Affairs (3) GC I II Study and practice of newsgathering on executive, legislative, and judicial levels in city, county, state and federal governments, with emphasis on news sources and interpretive writing. P, 206, 208.
414. The News Agency: Arizona News Service (1) GC [ 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.
415. The Editorial Page (3) GC I II Critical study of opinion-makers, with emphasis on editors and public-affairs columnists; analysis of editorial pages in a changing society; writing of editorials. P, 206.
416. **The Weekly Newspaper (3) GC I II** Community and suburban weeklies, including problems of news coverage, production, advertising and circulation. Integration of electronic text systems. Field trips.

417. **Sports News Writing (3) GC I** Students will cover sports events and write sports features. Interview and rewriting techniques. P, 206.

421. **Advanced Editing (3) GC II** Study of layout and typography for news, photographs, and feature articles in newspapers. P, 320.

422. **Publications Layout and Design (3) GC I** Theory and practice of layout, typography, and design for magazines. P, permission of dept.

450. **Community Journalism: The Tombstone Epitaph (3) GC [ Rpt. ] 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, 320, discussion of preparation with instructor.

451. **Community Journalism: El Independiente (3) GC [ Rpt. ] II** Class members work as editorial staff to produce a publication for the city of South Tucson. Intensive study of problems and responsibilities of journalism. P, 206, 208, 301, 320, discussion of preparation with instructor.

452. **Press Criticism: The Pretentious Idea (3) GC I II** Study of press criticism, including the publication of a press review. Open to majors only. P, 206, 208, 320, discussion of preparation with instructor.

470. **The Press and Society (3) GC I II** Critical study of press performance in current affairs; changing requirements for socially responsible and professional journalism in a democracy. (Identical with R.T.V. 470 )

471. **International Communications (3) GC I II** Study of world news systems, including news-gathering agencies, role of the foreign correspondent, the foreign press, and factors influencing international news flow.

497. **Workshop**
   a. **Color Photography (2) [ Rpt./1]** GC S Two-week field trip with fee.

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.

509. **Media in the Twentieth Century (3) I** The social, cultural, and economic role of a free press in American society. Interaction of press and government at judicial, executive, and legislative levels.

596. **Seminar**
   a. **History of Mass Media (3) I II**
   b. **International Communications (3) I II**
   c. **Reporting Governmental Affairs (3) I II**
   d. **Magazines (3) I II**
   e. **Electronic Media (3) I II**
   f. **Community Journalism (3) I II**
   g. **Journalism Education (3) I II**
   h. **Latin-American Press (3) I II**
   i. **News Analysis (3) I II**
   j. **Media Organization (3) I II**

660. **Research Methodologies I (3)** (Identical with Sp.C. 660 )

670. **Research Methodologies II (3)** (Identical with Sp.C. 670 )

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**LANDSCAPE ARCHITECTURE**

*(See Renewable Natural Resources)*

**LATIN**

*(See Classics)*

**LATIN AMERICAN STUDIES**

*Latin American Area Center*

Director: Michael C. Meyer
Assistant Director: Susan M. Deeds
Committee on Latin American Studies

Professors Michael C. Meyer (History), Director, Donald W. Carson (Journalism), Roger Fox (Agricultural Economics), Lanin A. Gyurko (Spanish and Portuguese), Boris S. Kozolchyk (Law), Edward J. Williams (Political Science)
Associate Professor Celestino Fernández (Sociology)
Assistant Professor Susan M. Deeds

The Latin American Area Center offers an interdisciplinary program leading to the Master of Arts degree with a major in Latin American studies. Programs are designed primarily for students planning government, business, teaching, or related careers. The Center assists its students in career development by providing counseling and information relating to internships and careers.

Applicants should indicate the intended area of concentration. A faculty member from the proposed area of concentration will evaluate the transcripts to determine whether there will be undergraduate deficiencies to be satisfied without graduate credit. Scores on the aptitude test of the Graduate Record Examination are strongly recommended.

The master’s program consists of 35 graduate units, with an area of concentration and two related areas. Minimum unit requirements are fifteen (including one research seminar) for the concentration and eight and six for the respective related areas. Concentrations are available in anthropology; economics; geography and regional development; political science; history; Portuguese; and Spanish. Related areas may be cultural or professional and may be chosen from among the following areas: agricultural economics; anthropology; art; economics; English as a second language; educational foundations and administration; family and consumer resources, geography and regional development; political science; history; journalism; law; library science; nursing; pharmacy; Portuguese; sociology; and Spanish.

Neither of these supporting fields may duplicate the principal field of concentration. Both Portuguese and Spanish are required, one at a level of competence and the other at a level of proficiency. Competence may be established by completion of Port. 202b or Span. 305 with a grade of B or above, or by an equivalency examination. Proficiency may be established by completion of Port. 405b or Span. 375 with a grade of B or above, or by an equivalency examination. The student and the adviser will determine which language should be emphasized. All students are required to complete at least one semester of 596a.

Doctoral students in other departments may elect a minor in Latin American studies. Requirements include a minimum of fifteen units in courses related to the student’s major and demonstrated competence, as defined above, in either Portuguese or Spanish.

495. Colloquium
a. Latin American Studies (3) GC II P, Span. or Port. proficiency.

595. Colloquium
d. Applied History (3) I (Identical with Hist. 595d, which is home)

596. Seminar
a. Latin American Studies (3) I P, Span. or Port. proficiency.

LAW

Associate Dean Armando Rivera
Associate Professors Mark L. Ascher, Theresa A. Gabaldon
No graduate degree is offered by the College of Law. The College welcomes, however, the enrollment of properly qualified graduate students in selected courses relevant to their degree objectives. Graduate students so enrolled may earn graduate credit as their performance warrants. Prior to registration, such students must obtain the written approval of the instructor of the course in question and the Executive Committee of the College of Law.

For information concerning the professional degree Juris Doctor, 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 (4)
607. Appellate Practice and Moot Court (1)
608. Evidence (4)
609. The Legal Profession (2)
610. Decedents' Estates (2)
611. Trusts and Fiduciary Administration (4)
612. Family Law (2)
613. Law and Medicine (2)
614. Workers' Compensation (2)
616. Private Corporations (3)
617. Corporate Finance (2) P, 616.
618. Antitrust Law (3)
620. Immigration Law (2)
621. Administrative Law (3)
622. Law Review (1 to 3) P
623. Conflict of Laws (3)
624. Labor Law (3)
626. Jurisprudence (3)
628. Comparative Law (3)
630. Legal Process (3)
631. Indian Law (2)
633. Commercial Transactions (4) P
634. Products Liability (2)
635a-635b. Insurance (2-3) P, 635a is not prerequisite to 635b.
638. Real Estate Transactions (3)
639. Community Property (2)
640. Mining and Public Land Law (3)
641. Water Law (3)
208 DEPARTMENTS AND COURSES OF INSTRUCTION

642. Federal Jurisdiction (3) II
643. 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 P, 610, 611.
649. Torts II (3) II
650. Criminal Law (3) II
651. Accounting and the Law (2) II
652. Income Taxation of Estates and Trusts (2) II P, 611, 646.
653. Advanced Appellate Practice and Moot Court (2) II
654. The First Amendment (3) II
655. Civil War Amendments (3) I
656. Law of the Elderly (2) I
658. Securities Regulation (3) II
659. Growth Controls (3) II (Identical with Geog. 659, which is home)
660. Land-Use Planning (3) II
661. Moot Court Board (2) II
662. Creditors' Remedies and Bankruptcy (3) II
665a-665b. Interviewing, Counseling and Negotiation (1-1) 665a is not prerequisite to 665b.
666. Lawyering Skills Outside the Courtroom (2) II P or CR 696cc or substantial clerking experience.
669. Preservation of Historic Environments (3) II 1985-86 (Identical with Ping. 669, which is home)
696. Seminar
   c. Juvenile Delinquency (2) I P, 609.
   e. Business Planning (3) II P, 616, 647.
   f. Current Constitutional Problems (3) I
   g. Mass Communication (3) II
   j. Child, Family and State (3) I
   m. Landlord and Tenant (2) I
   o. Law and Psychiatry (3) I
   t. Law and Technology (3) I II
   bb. Advanced Civil Procedure (3) I
   cc. Clinical Practice (2) II P, 606, 609, 645.

LIBRARY SCIENCE
(Graduate Library School)

Professors Margaret F. Maxwell, Acting Director, Ellen Altman, Donald C. Dickinson, Peter Hernon, Lawrence Clark Powell (Emeritus), Elinor C. Saltus (Emerita), Arnulfo D.T. Trejo, (Emeritus)
Associate Professors Helen M. Gothberg, Helen Renthal (Emerita), Rodes Trautman, Ronald A. Van De Voorde
The Graduate Library School offers programs leading to the Master of Library Science degree with a major in library science. The Master of Library Science degree qualifies graduates for professional positions in all fields of librarianship including academic, public, and special libraries. All students must pass a comprehensive final examination. To be qualified for school libraries, specified courses in education are necessary for certification. The Graduate Library School is accredited by the American Library Association.

The goals of the Graduate Library School are (1) to establish an academic atmosphere within which students develop competencies and skills necessary for present and future leadership in librarianship and information science, (2) to promote an active, cooperative program to serve the continuing education needs of the library and information-seeking community, (3) to create an atmosphere conducive to research and innovative projects, and (4) to promote a philosophy of librarianship that will enable students to work effectively in a professional setting.

Degrees

MASTER OF LIBRARY SCIENCE — For information concerning this degree see Requirements for Masters’ Degrees/Master of Library Science elsewhere in this catalog.

Holders of regular Arizona teaching certificates may acquire the school librarianship endorsement appropriate to their certificates by completing one of the following programs: elementary school — Li.S. 480, 502, 503, 505, 581, 582, and 693d; secondary school—Li.S. 485, 502, 503, 505, 581, 582, and 693d.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as result of the review.

417. Media in Instruction (3) GC I II S (Identical with S.Ed. 417)
441. Children’s Literature in Spanish (3) GC I (Identical with Span. 441)
443. Mexican-American Literature (3) GC II (Identical with Span. 443)
480. Literature for Children (3) GC I II Literature to promote literary appreciation and to meet the interests and needs of elementary school children. (Identical with Rdng. 480)
485. Literature for Adolescents (3) GC I II Literature to meet recreational and developmental needs of the junior and senior high school age, including some books for adults. Reviewing and book talks. (Identical with Rdng. 485)
486. Oral Presentation of Children’s Literature (2) GC II Principles and techniques of storytelling and of reading aloud to children; stories for different age groups, presentation of picture stories; practice in reading and telling stories and in planning the story hour. P, 480.
487. Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487)
488. Microcomputer Application in Education (3) GC I II S (Identical with Ed.F.A. 488)
503. Library Collection Development (2) I II Principles of collection development; evaluation and review of materials; selection tools; acquisition of materials; problems in selection, including censorship.
504. Foundations of Library and Information Services (2) I II Elements of librarianship, historical backgrounds, types of libraries, the role of the library in American life, current issues.
505. Basic Reference (3) I II Survey of general reference sources; discussion of reference technique.
506. Research Methods (2) I II Need and opportunities for research in librarianship; types of research; research methodology; study of research design; elementary statistics.
507. Library Management (3) I II 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) I (Identical with Agri. 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) II 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) I Introduction to quantitative methods for the design, analysis and control of library systems.

515. Library Cooperation and Networks (3) Study of the background and state of the art of library cooperative systems, networks, and bibliographic utilities.

520. Technical Service Problems (3) I Examination of problems in acquisitions, cataloging, serials, and other areas related to activities in academic, public, school, and special libraries; consideration of developing technology.

521. Advanced Cataloging (3) II Comparative study of Dewey Decimal Classification and Library of Congress Classification; advanced problems in descriptive cataloging, subject headings, and library filing.

522. Automated Alternatives to the Library Catalog (1) II Alternatives to the card catalog with consideration given to type of library function, size, and budget; comparisons of card, printed book, on-line, and micro-image catalogs. Field trips.

523. Indexing and Abstracting (3) II Theory and current practices for compiling manual and computer-produced indexes; vocabulary control and thesaurus construction; production and evaluation of indexes and abstracts.

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) I Administration of tax-supported libraries serving the general public, including problems of governmental relationships, community responsibilities, financial support, buildings, personnel, collections.

534. Library Service to Children and Young Adults (1) I Investigation of the programs and materials useful in working with children and young adults in libraries.

540. Academic Librarianship (3) I Present trends in academic libraries, including financial administration, collection evaluation, personnel requirements and building needs.

550. Special Librarianship (3) II Mission, organization and administration of the special library.

560. History of Books and Printing (3) I 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.

561. History of Children’s Literature (3) II 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 Elem. 561, Engl. 561, and Rdng. 561)


563. Communication in Libraries: Public Service (1) II Problems of face-to-face communication at public service desks.

570. Information Sources and Services In the Sciences (3) I 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 in the Social Sciences and Humanities (3) II Advanced bibliographic and reference sources in the humanities and social sciences, with emphasis on the structure of knowledge in the various disciplines and evaluation of user services.

573. Government Publications (3) II 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.
LINGUISTICS

576. Administration of Reference (2) I Theory of information service, policy development, special services, and administration of reference services. Open to majors only. P, 505.


582. Audiovisual Materials in Libraries (2) I Introduction to AV information resources for the library.

600. Introduction to Graduate Study in Music (3) (Identical with Mus. 600)

607. Planning Library Services (3) I The total planning cycle as a management approach to various library/information center services. Open to majors only. P, 506.

616. Coordination of Instructional Media Programs (3) II (Identical with S.Ed. 616)

617. Preparation of Instructional Materials (3) II (Identical with S.Ed. 617)

693. Internship
   a. Academic Library (2 to 4) [ Rpt./1] I II S. P, 502, 503, 505, 507, CR 540.
   b. Special Library (2 to 4) [ Rpt./1] I II S. P, 502, 503, 505, 507, CR 550.
   c. Public Library (2 to 4) I II S. P, 502, 503, 505, 507, CR 530.
   d. School Library (2 to 4) [ Rpt./1] I II P, 480 (elementary only) or 485 (secondary only), 502, 503, 505, CR 581.
   e. Community College Library (2 to 4) [ Rpt./1] I II S P, 503, 504, 507.

695. Colloquium
   e. Theory of Classification (1 to 3) I II
   g. Laboratory in Library Communications (1 to 3) I II
   f. Issues in Library and Information Science (1 to 3) [ Rpt./4 units]

LINGUISTICS

Professors Peter W. Culicover, Head, Richard Demers, Robert Michael Harnish (Philosophy), Adrienne Lehrer, Susan Steele

Associate Professor Richard T. Oehrle

Assistant Professor Ann Farmer

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, Chinese linguistics, Japanese linguistics, Native American linguistics, educational/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 advisers, 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: 400, 413, 414, 501, 544, and two of 422, 464, and 465.

MASTER OF ARTS — In addition to the courses listed above, students are expected to take the following: 540, either 502 or 514, and one year of course work in a non-Indo-European language. No thesis is required.

DOCTOR OF PHILOSOPHY — In addition to the courses listed above, students will take two seminars and additional advanced course work. All students must take 502 and 514. The language requirement varies with the specialization. A dissertation is required.

400. Foundations of Syntax (3) GC I Theory of generative grammar and its implications for linguistics; examination of phrase structure, transformational and interpretive rules.

411a-411b. Modern Japanese Grammar (3-3) GC (Identical with Or.S. 411a-411b)
413. Introduction to Phonetics and Phonology (3) GC Analysis of the articulatory and acoustic properties of the sounds used in human language. Introduction to basic notions of phonological theory, with emphasis on motivating the distinctive features.

414. Fundamentals of Phonological Theory (3) GC Principles which underlie current theories of phonology, concentrating on sound patterns and alternations and the relationship of these topics to linguistic rules.

417a-417b. Sanskrit Grammar and Texts (3-3) GC 1986-87 (Identical with Or.S. 417a-417b)

420a-420b. Linguistic Structure of Modern Chinese (3-3) GC (Identical with Or.S. 420a-420b)

422. Linguistic Semantics and Lexicology (3) GC II 1986-87 Study of word and sentence meanings, relationship between the lexicon and the grammar, idioms, metaphor, etymology, and change of meaning. P, one course in ling. (Identical with Phil. 422)

423a-423b. Theory of Spanish Syntax (3-3) GC (Identical with Span. 423a-423b)

426. Introduction to Arabic Linguistics (3) GC (Identical with Or.S. 426)

427. Applied Spanish Linguistics (3) GC I (Identical with Span. 427)

429. Pedagogical Linguistics: Applied Linguistics for Language Teachers (3) GC II (Identical with Or.S. 429)

430. Language Variation (3) GC I 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 ling.

445a-445b. Structure of an American Indian Language (3-3) GC In-depth linguistic analysis of selected phonological, syntactic, and semantic problems in an American Indian language, concentrating on native languages of the Southwest area. P, 400, 412. (Identical with A.In.S. 445a-445b)

450. Language and Social Issues (3) GC II S 1985-86 Systematic investigation of selected topics in social issues involving language from a linguistics perspective; "standard" versus "nonstandard" language, minority dialects, language attitudes and prejudice, and the role of language in the educational system.

451. Acquisition of Speech and Language (3) GC II (Identical with Sp.H. 451)


464. Semantics (3) GC 1985-86 (Identical with Phil. 464)

465. Pragmatics (3) GC 1985-86 Study of language use, its relationship to language structure and context; topics such as speech acts, presupposition, implication, performatives, conversations. (Identical with Phil. 465)

473. Natural Language Processing (3) GC II 1986-87 Introduction to the processes underlying speech production and comprehension: speech sounds, words, parsing, semantics and pragmatics (Identical with Phil. 473)

476. Language in Culture (3) GC II (Identical with Anth. 476)

477. Discourse and Text (3) GC II 1985-86 (Identical with Anth. 477)

480. Historical Comparative Linguistics (3) GC I (Identical with Anth. 480)

495. Colloquium a. Linguistics (1) [ Rpt./3] GC I

500. Linguistics for Nonmajors (3) I Conceptual foundations, methodology, and current theoretical frameworks. Students will carry out actual linguistic analysis. For students in fields other than linguistics.


502. Advanced Syntax (3) I Analysis of various grammatical constructions; treatments of the distinction between local and nonlocal dependencies. P, 501.

514. Advanced Phonology (3) I Phonological processes of natural language and their theoretical treatment including standard generative phonology and multilinear extensions of it, such as autosegmental phonology and metrical phonology. P, 413.
540. **Language Change and Reconstruction (3) II** Introduction to the methods in, theory of, and problems in reconstruction of phonology, syntax, and semantics. Data will be drawn from a variety of the world’s language families, but will concentrate on American Indian languages and languages with little or no written record.

544. **Language Universals (3) I** Consideration, from a typological viewpoint, of aspects of the phonological, syntactic, and semantic systems of a representative sample of the world’s languages.

583. **Sociolinguistics (3) I** (Identical with Anth. 583)

596. **Seminar**
   u. Case and Paninian Grammar (3) [Rpt.] II 1985-86 (Identical with Or.S. 596u, which is home)

600. **Current Issues in Linguistic Research (3) [Rpt./1]** Current research in linguistics, with emphasis on relationships among syntax, semantics, and phonology.

696. **Seminar**
   a. Syntax and Semantics (3) [Rpt./2] II
   b. Topics in Phonological Theory (3) [Rpt./2] II
   c. Diachronic Linguistics (3) [Rpt./2] II
   d. Current Issues in Syntactic Theory (3) II [Rpt./2]
   f. Linguistic Investigations and Applications (3) II (Identical with Sp.C. 696f, which is home)

**MANAGEMENT**

(See Management and Policy)

**MANAGEMENT AND POLICY**


Associate Professors Nicholas J. Aquilano, Michael K. Block, Robert W. Buckingham, Don B. Christianson, Marvin Fortman, Vernon L. Greene, Theodore H. Koff, David A. Tansik, Robert E. Tindall, Ronald J. Vogel

Assistant Professors Lawton R. Burns, J. Richard Harrison, Margaret A. Neale, Gregory B. Northcraft, Richard B. Polley, David Torres, Douglas Wholey

The department offers a program leading to the Master of Science degree in management and policy with concentrations in human resource management, operations management, organizational strategy, and policy and planning. The department also 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 business administration. 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 managerial accounting, economics, finance, organizational behavior, marketing, production, business law, business policy, statistics, and mathematics through calculus (Math. 119 and 123). A score in the seventieth percentile or better on the Graduate Management Admissions Test is required for admission consideration.

The program for the Master of Science degree in management and policy requires completion of thirty units, including a thesis. A minimum of sixteen units must be taken in courses open only to graduate students. Each graduate study program is individually planned in consultation with an adviser.

**General Management and Policy**

420. **Advanced Business Law (3) GC I-II** Negotiable instruments, partnerships, corporations, and property rights. P, CR 320 or admission to BPA graduate programs. (Identical with Acct. 420)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>426</td>
<td>Wills, Estates, and Trusts (3) GC I Wills, inheritances, estates, and trusts; the administration of estates, including the duties and liabilities of executors and trustees; basic estate and gift tax laws applicable to estate planning.</td>
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<td>500</td>
<td>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. Open only to students admitted to BPA graduate programs.</td>
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<td>552</td>
<td>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, M.I.S. 500, or Math. 119 and 123.</td>
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<td>554</td>
<td>Research Methodology (3) I Behavioral research techniques; bias, validity, reliability, and applicable statistical techniques; critiques of research articles and reports. P, 552.</td>
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<td>571</td>
<td>Management Strategy (3) I II Case method approach to problems and policies facing top management. May only be taken in the final semester of the M.B.A. program. P, 500b, 502, Fin. 511, Mktg. 500.</td>
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<tr>
<td>582a-582b</td>
<td>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, 275 or 552. 582a is not prerequisite to 582b.</td>
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<td>696</td>
<td>Seminar n. Research Design: Statistical Methods (2 to 4) I II</td>
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<td><strong>Criminal Justice Administration</strong></td>
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<td>436</td>
<td>Crime and Public Policy (3) GC I II Role of government in the prevention and control of crime.</td>
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<td>595</td>
<td>Colloquium f. Criminal Justice (3) [ Rpt./12 units] I II</td>
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<tr>
<td>693</td>
<td>Internship b. Criminal Justice (1 to 6) I II</td>
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<td>696</td>
<td>Seminar g. Criminal Justice Administration (1 to 3) I II</td>
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<td></td>
<td><strong>Health Services Administration</strong></td>
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<td>595</td>
<td>Colloquium c. Health Care (3) [ Rpt./12 units] I II</td>
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<tr>
<td>650</td>
<td>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. P, 601</td>
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<td>651</td>
<td>Health and Public Policy (3) I 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, 650. (Identical with Ping. 651 )</td>
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<td>653</td>
<td>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, 650.</td>
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<td>655</td>
<td>Efficiency Analysis in Health Administration (3) II Professional-level treatment of economic and related principles as they apply to the health-care industry, and of the impacts of health policy and program alternatives; case study method used. P, Econ. 500a. (Identical with Ping. 655 )</td>
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<td>693</td>
<td>Internship d. Health Services Administration (1 to 6) I II</td>
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<td>696</td>
<td>Seminar e. Health Services Administration (1 to 3) I II</td>
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<td><strong>Human Services Administration</strong></td>
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<td>595</td>
<td>Colloquium d. Aging and Society (3) [ Rpt./12 units] I II</td>
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### Management and Policy

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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>652</td>
<td>Management of Long Term Care Facilities and Programs (3) II</td>
<td>Problems and principles of management of facilities and community based programs providing health and social services to the chronically impaired. P, 650.</td>
</tr>
<tr>
<td>662</td>
<td>Aging and Public Policy (3) I</td>
<td>Policy framework for administration of programs, plans, priorities, and legislation related to the needs of the aging in modern society. (Identical with Ping. 662)</td>
</tr>
<tr>
<td>693</td>
<td>Internship</td>
<td>I. Long Term Care Administration (1 to 6) II</td>
</tr>
</tbody>
</table>

**Human Resource Management/Organizational Behavior**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>413</td>
<td>Administrative Leadership (3) GC I</td>
<td>Elements of leadership, as applied to selected administrative situations.</td>
</tr>
<tr>
<td>430</td>
<td>Personnel Policies (3) GC II</td>
<td>An integrative, case-oriented course focusing on problems and policies in the procurement, development, compensation, and motivation of personnel. P, 330 and six units in personnel mgmt. major.</td>
</tr>
<tr>
<td>432</td>
<td>Bargaining and Negotiation in Organizations (3) GC</td>
<td>Examination of the state of the art of bargaining and negotiation and the development of bargaining skills in a wide variety of business and interpersonal settings. P, 305.</td>
</tr>
<tr>
<td>433</td>
<td>Topics in Performance Appraisal (3) GC</td>
<td>Examination of theoretical and practical bases of various performance appraisal systems and techniques. P, 330.</td>
</tr>
<tr>
<td>444</td>
<td>Group-Process Methods in Management (3) GC II</td>
<td>Application of behavioral science knowledge to group functioning in public agencies with emphasis on observation, analysis, feedback and intervention in small groups; the SYMLOG theory and method of group analysis, along with other perspectives from social psychology and sociology. P, 472. (Identical with Soc. 444)</td>
</tr>
<tr>
<td>502</td>
<td>Organization Theory and Behavioral Relations (3) II</td>
<td>The interactions, effects, and interrelationships of managers, employees, and organizational structures and systems. Open only to students admitted to a BPA graduate program.</td>
</tr>
<tr>
<td>503</td>
<td>Human Resource Management (3) I</td>
<td>Principles, methods, research relevant to management of an organization's human resources, with emphasis on employment psychology, training, development, compensation. P, 305 or 502.</td>
</tr>
<tr>
<td>504</td>
<td>Organization Development and Change (3) II</td>
<td>Concepts and skills relevant to persons concerned with problem diagnosis and organizational development and change. P, 305 or 502.</td>
</tr>
<tr>
<td>525</td>
<td>Intermediate Complex Organizations (3) (Identical with Soc. 525)</td>
<td></td>
</tr>
<tr>
<td>580a-580b</td>
<td>Theory of Management and Organization (3-3)</td>
<td>Analysis of behavior in organizational systems; review of classical, behavioral, and contingency theories of management with a focus on internal systems phenomena. 580a: Organizations in their environments; analysis of organizations in the context of their environmental interfaces. P, 305 or 502. 580a is not prerequisite to 580b.</td>
</tr>
<tr>
<td>600</td>
<td>Behavioral Science Theory and Method in Management (3) [Rpt./1]</td>
<td>Conceptual and theoretical frameworks for the analysis of management problems from a behavioral science perspective. Relevant material drawn from social psychology, sociology, anthropology, and political science.</td>
</tr>
</tbody>
</table>
| 696         | Seminar                                                              | I. Organizational Behavior (3) [Rpt./6 units] II P, 600.  
                          | m. Organizational Theory (3) [Rpt./6 units] II P, 600. |

**Operations Management**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</tr>
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<tbody>
<tr>
<td>473a-473b</td>
<td>Production and Operations Management (3-3) GC</td>
<td>GC Productive systems, including service type industries; activities entailed in selecting, designing, operating, controlling, and updating systems. 473a: General coverage, including planning, scheduling and control systems. 473b: Case analyses in a manufacturing environment. P, 373.</td>
</tr>
<tr>
<td>474</td>
<td>Work Simplification (3) GC I II</td>
<td>Work simplification and motion economy; methods of increasing productivity of employees; flow process charts and flow diagrams; appraisal of fatigue. P, 305.</td>
</tr>
<tr>
<td>475</td>
<td>Productivity Improvement (3) GC II</td>
<td>Productivity measurement; monitoring with statistical quality control techniques; improvement through use of small group processes. P, 373.</td>
</tr>
</tbody>
</table>
476. Management of Service Operations (3) GC I Application of operations management concepts to service organizations and interaction with other functional areas; case analyses of banks, airlines, health care, motels, food service, others. Field trip. P, 373.

477. Materials and Logistics Management (3) GC I Organization, management, and control of material flow processes; logistical strategies and relationships of procurement, handling, warehousing, transportation, and inventory control. P, 373, 473a.

478. Project Management (3) GC 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

479. Sociotechnical Systems (3) GC I Theory and practice of installing high-commitment work systems to increase productivity and improve the quality of working life.

572. Operations Management (3) I Intended for students without a background in production management. Survey of techniques useful in operating manufacturing and service production.

585. Material Requirements Planning and Control (3) II Material management with emphasis on forecasting and inventory theory within a dependent demand environment.

Policy and Planning

485. Zoning Fundamentals (3) GC I Survey of the zoning process; nature, structure, and function of zoning, problems of zoning administration; new concepts of zoning content and administration. (Identical with Ping. 485)

506. Fundamentals of Physical Planning (3) I Basic considerations in site analysis and planning, and transportation and utility systems; subdivision planning and plat review. (Identical with Ping. 506)

507. Social Service Planning (3) I Survey of the variety of planning efforts designed specifically to increase social welfare through the delivery of services using historical, comparative, and evaluative perspectives. (Identical with Ping. 507)

575. Housing and Residential Areas (3) II Physical, social, and economic aspects of housing development and residential areas and their relationship to other land uses and functions. (Identical with Ping. 575)

602. Analytic Methods in Planning and Management (3) II Methods and models for program planning and policy analysis; forecasting, service demand, facility location, capital investment programming, task sequencing, program analysis and evaluation. P, 457 or 552. (Identical with Ping. 602)

609. Policy Problems in Structure and Change (3) II Problems presented by structure and change in modern urban society from the standpoint of social systems analysis; evaluation of strategy and effectiveness of public policy and planning. (Identical with Geog. 609, Ping. 609)

612a-612b. Projects in Policy and Planning (2-3) Lab. and field projects simulating various aspects of professional practice. Open to majors only. P, 12 units toward M.S. (Identical with Ping. 612a-612b)

693. Internship g. Policy and Planning (1 to 4) S Open to majors only. (Identical with Ping. 693g)

696. Seminar h. Land-Use Regulation (3) I II P. (Identical with Ping. 696h)

696. Seminar i. Legal Inquiry in Policy and Planning (3) II (Identical with Ping. 696i)

696. Seminar j. Environmental Planning (3) I II (Identical with Ping. 696j)

696. Seminar k. Planning Administration (3) I II (Identical with Ping. 696k)

Public Management

411. Public Administration and the Mexican-American (3) GC I Hispanic-American cultural and historical impact on public administration in the southwestern U.S. from 1775 to the present; patterns of contemporary Spanish-speaking participation in state and local governmental administration of services. (Identical with Ed.F.A. 411 and M.A.S. 411)

514. Cost-Benefit Analysis (3) II (Identical with A.Ec. 514)

573. Business, Government and Society (3) II Relationships between the institutions of business and government; economic, social and political aspects. P, 305 or 502.
595. Colloquium
   a. Public Management (3) [Rpt./12 units] I II

601. Public Management (3) I Fundamentals of management structure and process in public sector: emphasis on professional practice. Open only to students admitted to a BPA graduate program.

605. Research and Evaluation in Public Administration (3) I Research and evaluative methodologies which support public sector policies and administration, including the philosophical basis of these methods and a research design exercise. P, 552, 601.

610a-610b. Fiscal and Budgetary Administration of Public Agencies (3-3) 610a: Internal fiscal operation and the budgetary cycle of public and nonprofit agencies. P, 610. Acct. 572. 610b: Cost/benefit analysis for public agencies. 610a is not prerequisite to 610b. (Identical with Pol. 610a-610b)

621. Administrative Patterns in the Federal System (3) I Legal, political, and social framework of interjurisdictional and interagency relations; trends, emerging issues, and devices for securing coordination and responsibility.

693. Internship
c. Public Management (1 to 6) I II

696. Seminar
   a. Development Administration (1 to 3) I II
   b. Program Planning and Development (1 to 3) I II
   c. Performance Measurement and Accountability (1 to 3) I II

MANAGEMENT INFORMATION SYSTEMS

Professors Jay E. Nunamaker, Jr., Head, Seymour Goodman, James F. LaSalle, Averill Law, Roy E. Marsten, Richard O. Mason
Associate Professor Benn Konsynski, III
Assistant Professors Arnold Greenfield, Matthew Saltzman, Robert Schneider, Y. Richard Wang, E. Sue Weber

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 business administration) 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 headnotes elsewhere in this catalog.

Management information systems involves the use of computers in management 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 score in the seventieth percentile or above on the Graduate Management Admissions Test. Applicants must also have completed preparatory work in finite mathematics, calculus, statistics, economics, business law, accounting, business finance, marketing, organizational behavior, production and business policy. If a student enrolls without the proper preparatory course work, the student may be required to complete M.I.S. 400, Acct. 550, 551; M.A.P. 502; Mktg. 500; and Fin. 511. Only 9 units of deficiency credit, excluding M.I.S. 400, may be included in the required 39 units. Proficiency in a programming language is also required. Students without fully adequate preparation may be admitted with deficiencies which must be removed without graduate credit.

The program requires the completion of 39 units, 30 of which must be in the major. A typical plan of M.I.S. courses would consist of 511, 521a, 531a, 531b, 541a, 541b, 551a, a master's report and two electives. Courses may be waived as a result of prior preparation. Minimum requirements after waivers must include at least 30 units in M.I.S., and at least 16 units at the 500 and 600 level. A master research report (3 units) or a master thesis (6 units) is required.
218 DEPARTMENTS AND COURSES OF INSTRUCTION

422. Mathematical Programming and Applications (3) GC Formulation and solution of mathematical programming models with applications to decision problems involving profit maximization or cost minimization. Topics include linear programming, network flow programming, and integer programming. P, 301, Math. 119. (Identical with C.Sc. 422)

461. Management Information Systems (3) GC I II (Identical with Acct. 461)

501. Behavioral and Economic Aspects of Information Systems (3) I Data validation and data completeness; comparison of centralized and decentralized systems; computer pricing policies and cost allocation; economies of scale; legal considerations and computer frauds; security considerations; problems of changing computer systems. Open only to students admitted to BPA graduate programs.

501. Management Information Systems (3) II Computer problem solving using BASIC and canned programs; conceptual and practical foundations of information processing support for management and decision-making functions; cost benefit analysis. Open only to students admitted to BPA graduate programs.

511. Behavioral and Economic Aspects of Information Systems (3) I Data validation and data completeness; comparison of centralized and decentralized systems; computer pricing policies and cost allocation; economies of scale; legal considerations and computer frauds; security considerations; problems of changing computer systems. Open only to students admitted to BPA graduate programs. P, 441 or 501.

521a-521b. Advanced Systems Modeling and Simulation (3-3) Optimization models of information systems; application of graph theory and integer programming; branch and bound; simulation of operating systems, computer networks, file organizations, memory management and relevant areas involving M.I.S. policy decisions. Open only to students admitted to BPA graduate programs. P, 501, M.A.P. 552, Math. 119. (Identical with C.Sc. 521a-521b)

531a-531b. File Organization and Data Base Management (3-3) Data and storage structure; file design and analysis of data organization techniques; indexed sequential, clustered, multilist and inverted files; D.B.M.S. design and implementation of network (CODASYL), hierarchic and relational data bases. Open only to students admitted to BPA graduate programs.

541a-541b. Computer-Aided Information Systems Analysis and Design (3-3) Analysis and logical design of M.I.S. and management control systems; techniques for stating and analyzing information systems requirements; optimization models of subsystems; hardware/software selection and evaluation; system implementation and performance evaluation. Open only to students admitted to BPA graduate programs. (Identical with C.Sc. 541a-541b)

551a-551b. Business Systems Programming Methods (3-3) Business systems programming environment; structured COBOL; sequential and indexed sequential files; program management standards; advanced features of COBOL; direct and multi-key files; RPG; access methods. Open only to students admitted to BPA graduate programs. P, 501.

553. Operations Analysis (3) II Modeling techniques for decision-making in operations analysis and production; applications include production mix, lot size, logistics, factory and warehouse location, inventory management, queueing processes, scheduling, PERT/CPM, and strategic policy decisions. Open only to students admitted to BPA graduate programs. P, M.A.P. 552.


577. Nonlinear Mathematical Programming (3) I II S Introduction to the formulation, solution, and implementation of nonlinear mathematical programming models; main methodological areas of nonlinear programming; representative applications; Medium-scale models will be run on the computer. P, 421a.

578. Systems Design for Management (3) I Application of computer technology to distributed processing; computer-aided tools in support of administration; electronic mail, telecommuting. P, 501.


596. Seminar
a. Computers in Auditing (3) I II P, 341 or Acct. 461. (Identical with Acct. 596a)
MARKETING 219

696. Seminar
d. Advances in Optimization Theory (3) I II P, 421a.
e. Recent Advances in Management Science (3) I II P, 421a.
g. Advanced Topics in Data Management (3) I II P, 531b.
h. Master's Report Projects (3) I II S Open to majors only.

796. Seminar
a. Research Methodology (3) [ Rpt./6 units] Open to majors only.

797. Workshop

MARKETING

Professors Joseph W. Newman, Head, Gary M. Munsinger, Lyman E. Ostlund
Associate Professors Richard A. Scott, Melanie R. Wallendorf, Robert A. Westbrook
Assistant Professor William C. Black

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 and the Doctor of Philosophy degrees with a major in business administration. For information concerning these degrees see Requirements for Master's Degrees/Master of Business Administration and the headnotes under 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 (M.I.S. 400 ). A limited number of background requirements may be satisfied after admission, but credit so earned will not count toward the thirty units required for the M.S. degree with a major in marketing. A score on the Graduate Management Admissions Test in the seventy-fifth percentile or above and an academic average of approximately “B” or better are required for admission consideration.

For the Master of Science degree with a major in marketing, at least eighteen units must be completed in marketing. A minimum of sixteen of the thirty units required for the degree must be in courses open only to graduate students. The writing of a thesis is optional.

420. Marketing for Nonprofit Organizations (3) GC II Application of marketing concepts and tools for public agencies, health services, public transportation, the arts, schools, museums, churches, etc.; role of marketing planning, research, product and service development, pricing, promotion, public relations. P, 381.


454. Management of Sales Operations (3) GC I 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.


458. Retailing Management (3) GC I II Management of the retail store, its environment, personnel, buying, merchandising, pricing, advertising, promotion, selling, expense control and customer service. P, 361; Acct. 200.

470. Marketing and Public Policy (3) GC I Trends in public opinion, legislation and practices of governmental regulatory bodies; implications for marketing decision making; role of marketing research in public policy development. P, 361.
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 BPA graduate programs.

530. **Management of Marketing Communications** (3) I Application of communications theory and research findings in advertising, sales promotion, publicity, personal selling; planning, conduct and administration of programs of information and persuasion. P, 500.

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.

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.

572. **Research and Marketing Management** (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, M.A.P. 552.

695. **Colloquium**
   - a. **Research in Marketing** (1) [Rpt./7] II

696. **Seminar**
   - a. **Marketing Research Methodology** (3) I II P, 500, M.A.P. 552.

**MATERIALS ENGINEERING**

**MATERIALS SCIENCE AND ENGINEERING**

Professors William G. Davenport, Head, Louis J. Demer, Kenneth L. Keating, Thomas M. Morris (Emeritus), Daniel J. Murphy (Emeritus), David R. Poirier, Subhash H. Risbud, Sigmund L. Smith (Emeritus)

Associate Professors David C. Lynch, Srinidhi Raghavan

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.

Applicants with undergraduate backgrounds in related disciplines such as chemistry, mathematics, physics, or other engineering fields may be admitted to the Master of Science degree program. Ultimately, that program requires the completion of the same mathematics, chemistry (except analytical chemistry), and physics background (as well as certain materials science and engineering courses) that is required for the undergraduate curriculum in materials science and engineering. A limited number of deficiencies may be satisfied after admission to the Master of Science degree program and, in certain cases, graduate credit may be earned for such courses.

**Degrees**

**MASTER OF SCIENCE** — All students must complete nine units of 500-level coursework including 510. In addition, all students must complete nine units of regularly scheduled course work and eight units of thesis. Each student who does not have previous credit for
equivalent courses must complete M.S.E. 411, 412, 430aR, 430bR, and one of M.S.E. 401R, 420, or 450R. However, not more than six units from this required group may be applied toward meeting the requirements for the master's degree. All students must also demonstrate proficiency in the subject matter of M.S.E. 224 and 310.

**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 area. Proficiency in computer techniques or in some field of applied mathematics is also required. 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 consideration as well as scientific aspects of the problem.

401R. Mineral Processing (3) GC I Unit operations employed for the beneficiation of minerals. Field trip. P, 221 or 411.

401L. Mineral Processing Laboratory (1) GC I Lab. experiments dealing with unit operations. P, 401R or CR.

403. Flotation (3) GC II Theory and application of surface chemical principles to mineral separation and concentration via flotation and flocculation, including process control. 2R, 3L. P, 401R.


412. Metallurgical Physical Chemistry (3) GC II Physical, chemical topics of particular concern to metallurgical engineers, including kinetics, electrochemistry, and surface chemistry. P, 310, Math. 223.

420R. Extractive Metallurgy (3) GC II Unit processes employed in extractive metallurgy. Field trip. P, 224, 310, 411.

420L. Process Metallurgy Laboratory (1) GC II Lab. experiments involving application of thermodynamic and transport phenomena fundamentals to metallurgical processes. P, 224, 310, 411.

421. Process Metallurgy of Iron and Steel (3) GC I Reduction, conversion, and refining of steel and ferrous alloys; slag-metal equilibria, and applications of process engineering principles to sinter plants, blast furnaces, and steelmaking furnaces. P, 310, 411, 420R.

422. Extractive Metallurgy of Nonferrous Metals (2) GC II Extractive metallurgy of selected nonferrous metals considered from the standpoint of an economic and process analysis. P, 420R.

423. Electrometallurgy (3) GC I Principles and applications of electrometallurgy in aqueous and fused salt solutions. 2R, 3L. Open to Ch.E. or Met. majors only.

424. Ceramic and Refractory Materials (2) GC I Nonmetallic materials used in high temperature applications. P, 331R, 430aR or Chem. 480b, or CR.

426. Hydrometallurgy (3) GC II Principles of hydrometallurgy; chemical and physical classifications of processes; liquid-solid separation techniques; solution purification and concentration and metal recovery technology. P, 224, 401R, 412.

430aR-430bR. Physical Metallurgy (3-3) GC The structure and behavior of metals and alloys; with fundamental theory of metallurgical phenomena. P, 310 or CR; Phys. 103b; Chem. 103b, 104b; C.E. 217 or CR.

430aL-430bL. Physical Metallurgy Laboratory (1-1) GC Fundamental lab. techniques for the preparation, examination, and interpretation of microstructures of metals and alloys; correlation with physical and mechanical behavior under applied conditions. P, 430aR-430bR or CR.

432. X-Ray Methods in Metallurgy (3) GC II Fundamentals of X-ray diffraction and fluorescence analysis; application of X-ray techniques to metallurgical problems. 2R, 3L. P, 430bR or CR.


435. Corrosion (2) GC II The science of corrosion reactions and their application to engineering problems. P, 331R; 412 or Chem. 480b or CR. (Identical with Ch.E. 435)
222 DEPARTMENTS AND COURSES OF INSTRUCTION

441. Metallurgical Engineering Design Economics (2) GC I Principles of process design, plant design, and economics involving equipment design, preliminary process design, and capital and operating cost estimation. P, CR 442a.

442a-442b. Metallurgical Plant Design (2-1) GC Practice in the application of engineering principles to the design of a metallurgical process. 442a: 1R, 2L. 442b: 3L. P, CR 441.

450R. Unit Operations in Metal Processing (3) GC I Unit operations employed in the solidification and mechanical working of metals. P, 331R, 430aR; 411 or A.M.E. 340b; C.E. 217. (Identical with A.M.E. 450R)

450L. Metal Processing Laboratory (1) GC I Lab. experiments in metal processing, including solidification and mechanical forming processes. Field trip. P, CR 450R. (Identical with A.M.E. 450L)

451. Advanced Metal Processing (3) GC II Consideration in detail of modern refining, casting, and surface treatment processes, with emphasis on the relation between process variables and product properties. P, 450R.

452. Nondestructive Evaluation of Materials (3) GC II Introduction to the field of nondestructive testing of metals, with emphasis on application of magnetism, penetrants, radiography, ultrasonics, electronics, and other methods of evaluation. 2R, 3L. P, 331R, 430bR or N.E.E. 331.

457. Integrated Circuit Technology Laboratory (3) GC I (Identical with E.C.E. 457)

460. Health Hazards in the Mine Environment (2) GC II 1985-86 (Identical with Mn.E. 460)

461. Accident Prevention in the Mine Environment (2) GC II 1986-87 (Identical with Mn.E. 461)

501. Advanced Mineral Processing (3) II Advanced study of mineral processing theory and applications, and analysis of mineral processing systems. P, 401R.

510. Advanced Metallurgical Thermodynamics (3) I Treatment of thermodynamics of condensed phase multicomponent systems, with emphasis on metallurgical applications. P, 310.

513. Advanced Phase Diagrams (3) I Multicomponent constitution diagrams involving metals and ceramic materials. P, 430aR.

520. Advanced Metallurgical Process Engineering (3) II Analysis and synthesis, from a thermodynamic, kinetic, and transport phenomena viewpoint, of a variety of ferrous and nonferrous metallurgical processes. P, 310, 411.

532. Solid-Fluid Reactions (3) I (Identical with Ch.E. 532)

533. Imperfections in Metals (3) I Nature, causes and behavior of imperfections in the crystal structure of metals, of microscopic and macroscopic discontinuities in polycrystalline metal aggregates; their effects on various properties. Field trip. P, 430bR, Math. 254.


535. Advanced Microstructural Characterization (3) I Theory and applications of modern techniques for characterizing chemical and microstructural features of solids; transmission and scanning electron microscopy, microprobe, and Auger analysis. 2R, 3L. P, 430aR, 432.

595. Colloquium
   a. Materials Colloquium (1) [ Rpt./5] II

MATHEMATICS
(See also Applied Mathematics)


Assistant Professors Christopher Jones, Daniel Meiron, John N. Palmer, Robert Valentini
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, 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 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 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 and modern algebra at the level of 415. 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 two year-long courses at the 400 level or one year-long course at the 500 level in mathematics and between nine and twelve units of approved work outside the department. No thesis is required.

**MASTER OF SCIENCE** — This program is for students who wish to earn all of their graduate credits in mathematics. Thirty graduate units in mathematics are needed: at least 18 units must be at the 500 level, some in required basic courses covered on the oral exam. A thesis is not required, but up to six units may be earned if the student elects to submit one.

**DOCTOR OF PHILOSOPHY** — Prior to taking the preliminary examination, the student must complete all major and minor course work. The major course work consists of at least 36 graduate mathematics units. Of these, no more than 12 can be at the 400 level, and several will be in basic courses covered on the preliminary exam. Commonly the minor, consisting of at least 12 units of approved courses, is within the department in a concentration different from the major. A minor consisting of approved courses outside the department is also encouraged. There is a language requirement which can be satisfied in any two of the following: French, German, Russian, or computer programming. The principal component of the program is the completion of a dissertation involving original creative 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, research includes finite groups, rings, associative algebras, algebraic number theory, and primality testing. Research in analysis is being carried out on unbounded operators, quantum fields, relativity, and nonlinear problems of ecology, chemistry, and fluid dynamics. In geometry, there is work on convex sets, incidence geometry, and fibre bundles; in probability and statistics, projects involve geostatistics, reliability theory, and nonparametric inference. A detailed summary of faculty research appears yearly and is available on request.

402. Mathematical Logic (3) GC II 1985-86 Sentential calculus, predicate calculus; consistency, independence, completeness, and the decision problem. Designed to be of interest to majors in math. or phil. P, 125a or Phil. 325. (Identical with C.Sc. 402)

403. Foundations of Mathematics (3) GC II 1986-87 Topics in set theory such as functions, relations, direct products, transfinite induction and recursion, cardinal and ordinal arithmetic; related topics such as axiomatic systems, the development of the real number system, recursive functions. P, 215. (Identical with Phil. 403)
224 DEPARTMENTS AND COURSES OF INSTRUCTION

404. History of Mathematics (3) GC I The development 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 century. Not applicable to M.A., M.S., or Ph. D. degrees for math majors. P, 125b.

405. Mathematics in the Secondary School (3) GC II Not applicable to B.A., B.S., M.A., M.S., or Ph.D. degrees for math majors. (Identical with S.Ed. 405)

410.* Matrix Analysis (3) GC I II General introductory course in the theory of matrices. Advanced-degree credit not available to math. majors. P, 123 or 125b.


415. Introduction to Abstract Algebra (3) GC I Introduction to groups, rings, and fields P, 215.

416. Applications of Algebra (3) GC II Various applications of abstract algebra, e.g. to coding theory, crystallography, etc. P, 415.

420. Calculus of Variations (3) GC I 1985-86 Euler equations and basic necessary conditions for extremum, sufficiency conditions, introduction to optimal control, direct methods. P, 225, and 254 or 255.

421. Fourier Series and Orthogonal Functions (3) GC I Linear spaces, orthogonal functions, Fourier series, Legendre polynomials and Bessel functions. P, 225 and 254 or 255.

422a-422b.* Advanced Analysis for Engineers (3-3) GC Laplace transforms, Fourier series, partial differential equations, vector analysis, integral theorems, matrices, complex variables. Not applicable to M.A., M.S., or Ph.D degrees for math majors. Credit allowed for 422a or 322, but not for both, P, 223 or 225, and 254 or 255. 422a is not prerequisite to 422b. Both 422a and 422b are offered each semester.

423. Intermediate Analysis (3) GC I II Elementary manipulations with sets and functions, properties of real numbers, topology of the real line, continuity, differentiation, sequences and series of real valued functions of a real variable, with emphasis on proving theorems. Not applicable to graduate programs in math. P, 223 or 225.

424.** Elements of Complex Variables (3) GC I II Complex numbers and functions, conformal mapping, calculus of residues. P, 223 or 225.

**Credit will be allowed for only one of 424 or 422b. 422a-422b will not be considered a two-semester course at the 400 level in the Master of Arts degree program.

425. Advanced Calculus I (3) GC II Continuity and Riemann integration in one or two dimensions, improper integrals, uniform convergence, differentiation in n-space, inverse function theorem. P, 423.

426. Advanced Calculus II (3) GC I Curves, surfaces, change of variables in multiple integrals; extremal properties; theorems of Green, Gauss, and Stokes; exact differentials. P, 425.

434. Introduction to Topology (3) GC I Properties of metric and topological spaces and their maps; topics selected from geometric and algebraic topology, including the fundamental group. P, 423.

436. Metric Differential Geometry (3) GC II Differential geometry of surfaces; nonintrinsic geometry: fundamental forms, Gaussian and mean curvatures; intrinsic geometry: Theorema Egregium, geodesics, Gauss-Bonnet theorem. P, 223 or 225, and 254 or 255.

443. Theory of Graphs and Networks (3) GC I 1985-86 Undirected and directed graphs, connectivity, circuits, trees, partitions, planarity, coloring problems, matrix methods, applications in diverse disciplines. P, 119 or 215 or 223. (Identical with C.Sc. 443)


447. Combinatoria1 Mathematics (3) GC II 1986-87 Enumeration and construction of arrangements or designs, theorems on existence and nonexistence of designs, applications to design of experiments and error correcting codes. P, 215 or 243.


*Credit allowed for only one from each of the following groups: 455 or 456; 410 or 413.

461. Elements of Statistics (3) GC I II Probability spaces, random variables, standard distributions, point and interval estimation, parametric and nonparametric hypothesis testing. Math. majors will not receive grad. credit. P, 123 or 125b. (Identical with Stat. 461)


473. Theory of Computation (3) GC II (Identical with C.Sc. 473)

475a-475b. Mathematical Principles of Numerical Analysis (3-3) GC 475a: Analysis of errors in numerical computations, solution of linear algebraic systems of equations, matrix inversion, eigenvalues, roots of nonlinear equations, interpolation and approximation. P, 215; 223 or 225; 254 or 255; and a knowledge of a scientific computer programming language. 475b: Numerical integration, solution of systems of ordinary differential equations, initial value and boundary value problems. (Identical with C.Sc. 475a-475b)

476. Computational Methods of Algebra (3) GC II Applications of machine computation to various aspects of algebra, such as matrix algorithms, character tables and conjugacy classes for finite groups, cost enumeration, integral matrices, crystallographic groups. P, 410 or 413 and a knowledge of a scientific computer programming language. (Identical with C.Sc. 476)

477. Game Theory and Mathematical Programming (3) GC II 1985-86 Linear inequalities, games of strategy, minimax theorem, optimal strategies, duality theorems, simplex method. P, 410 or 413 or 415. (Identical with C.Sc. 477)

478. Operational Mathematics (3) GC I Basic concepts of systems analysis, Fourier and Laplace transforms, difference equations, stability criteria. P, 421 and 424, or 422b.

487. Microcomputers in Education (3) GC I II S Not applicable to B.A., B.S., M.A., M.S., or Ph.D. degrees for math majors. (Identical with Ed.F.A. 487)

515a-515b. Modern Algebra (3-3) Structure of groups, rings, modules, algebras; Galois theory. P, 415.

516a-516b. Algebraic Number Theory (3-3) 1985-86 Dedekind domains, complete fields, class groups and class numbers, Dirichlet unit theorem, algebraic function fields. P, 515b.

517a-517b. Group Theory (3-3) 1986-87 Selections from such topics as finite groups, noncommutative groups, abelian groups, characters and representations. P, 515b.

518. Topics in Algebra (3) [ Rpt. ] II Advanced topics in groups, rings, fields, algebras; content varies.

519. Topics in Number Theory and Combinatorics (3) [ Rpt. ] II Advanced topics in algebraic number theory, analytic number theory, class fields, combinatorics; content varies.


529. Topics in Modern Analysis (3) [ Rpt. ] II Advanced topics in measure and integration, complex analysis in one and several complex variables, probability, functional analysis, operator theory; content varies.
534a-534b. Topology (3-3) 1986-87 Point set topology, homotopy, homology. Applications, such as manifolds, duality, fixed point theorems, solutions to differential equations. P, 415 and 434.

536a-536b. Calculus of Tensors and Exterior Differential Forms (3-3) 1986-87 Affine tensors, tensor analysis on differentiable manifolds, calculus of exterior differential forms; calculus of variations, Riemannian geometry, applications to field theories. P, 423.


538. Topics in Geometry and Topology (3) [ Rpt.] I II Advanced topics in point set and algebraic topology, algebraic geometry, differential geometry; content varies.

539. Algebraic Coding Theory (3) II 1985-86 Construction and properties of error correcting codes; encoding and decoding procedures and information rate for various codes. P, 415. (Identical with E.C.E. 539)

555a-555b. Partial Differential Equations (3-3) 1985-86 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, 525a or 585a.

556a-556b. Dynamical Systems and Chaos (3-3) 1985-86 Qualitative theory of dynamical systems, phase space analysis, bifurcation, period doubling, universal scaling, onset of chaos. Applications drawn from atmospheric physics, biology, ecology, fluid mechanics and optics. P, 422a-422b or 454.


567a-567b. Statistical Inference (3-3) 1985-86 A decision theoretic approach to estimation and hypothesis testing, sequential methods, large sample methods. P, 423, and 464 or 564a. (Identical with Stat. 567a-567b)


579. Topics in Applied Mathematics (3) [ Rpt.] 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.


585a-585b. Principles and Methods of Applied Mathematics (3-3) Boundary value problems; Green's functions, distributions, Fourier transforms, the classical partial differential equations (Laplace, heat, wave) of mathematical physics. Linear operators, spectral theory, integral equations, Fredholm theory. P, 424 or 422b or CR 525a.

586. Case Studies in Applied Mathematics (1 to 3) [ Rpt./6 units] 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.


588. Topics in Mathematical Physics (3) [ Rpt.] I II Advanced topics in field theories, mathematical theory of quantum mechanics, mathematical theory of statistical mechanics; content varies.

589. Nonlinear Wave Motion (3) II 1986-87 Nonlinear partial differential equations describing wave phenomena in water, gases, plasmas, lasers; shocks, modulated wave trains, parametric resonance, solitons and exactly solvable equations. P, 422b or 456 or 455.
596. Seminar
   a. Topics in Mathematics (3) [ Rpt./1 ] S

636. Information Theory and Coding (3) II 1986-87 (Identical with E.C.E. 636 )

MECHANICAL ENGINEERING
(See Aerospace and Mechanical Engineering)

MEDICAL TECHNOLOGY
(See Health-Related Professions)

MEDICINE

Interdepartmental

495. Colloquium
   a. Introduction to the Neurosciences I (2) GC P, Consult dept. before enrolling. (Identical with
      Anat. 495a and Psio. 495a )
   b. Introduction to the Neurosciences II (2) GC P, 495a or consult dept. before enrolling. (Identical
      with Neur. 495b, Psio. 495b and Psyi. 495b )

596. Seminar
   Many interdepartmental seminars are numbered at both the 500 and the 800 levels. See 896
   below for a complete listing.

801. Preparation for Clinical Medicine (1 to 12) I II No grade is given until the full 12 units are
     completed.

802. Human Behavior and Development (6) I II

896. Seminar
   a. Introduction to Forensic Pathology (1 to 3) II
   j. * Cardiovascular Pharmacology (2)
   n. Research Methods for Clinical and Epidemiological Studies (2) II P, Graduate students must
      consult the department before enrolling.
   s. * Fluid and Electrolyte Balance and Renal Immunology (2)
   t. * Pathophysiology of Respiratory Diseases (2)
   aa. Introduction to Computers in Medicine (2)
   bb. * Geriatrics-Gerontology (1 to 3) II
   dd. * Maternal/Child Health (1 to 3)
   ee. * Clinical Epidemiology (2)
   gg. * Medical Jurisprudence (2)
   pp. * Medical Sexuality (2)
   uu. * Physical and Biological Basis of Nuclear Medicine (2)
   zz. * Pathogenesis and Approach to Immunological Diseases (2)

*Available as both 496 and 896.

Anatomy

See Anatomy elsewhere in this catalog.

Anesthesiology

Professors Burwell R. Brown, Jr., Head, I. Glenn Sipes
Associate Professors Stuart R. Hameroff, Charles W. Otto, A. Jay Gandolfi
Assistant Professors Randall C. Cork, Joseph A. Gallo, Jr., Randall S. Prust, Reynolds J.
Saurders
228 DEPARTMENTS AND COURSES OF INSTRUCTION

800. Research (1 to 6) [Rpt./1]

810. Clerkship
   a. Anesthesiology (1 to 18)

815. Subspecialty
   p. Critical Care Medicine (1 to 18) (Identical with I.Med. 815p)

891. Preceptorship
   a. Anesthesiology and Subspecialties (1 to 18)
   c. General Anesthesiology (4 - 6)

Biochemistry

See Biochemistry elsewhere in this catalog.

Family and Community Medicine

Associate Professors Peter J. Attarian, Frank A. Hale, Gail G. Harrison, Daniel O. Levinson
Assistant Professors Dorian H. Cordes, Ronald S. Fischler, Jonathan C. Hake, Craig L. McClure, Michael K. Magill, Ronald E. Pust, Arthur B. Sanders, Barry D. Weiss

500. Research (2 to 16) [Rpt./2] . P, basic science courses.

549. Interdisciplinary Approaches to Health Care of the Aged (3) S (Identical with Ph.Pr. 549)

588. Clinical Anthropology (3) I II (Identical with Nurs. 588)

596. Seminar
Some seminars are numbered at both the 500 and the 800 levels. See 896 below for a complete listing.

696. Seminar
   a. Research Topics and Methodologies in Family and Community Medicine (1) [Rpt./1] I II Consult dept. before enrolling.

800. Research (2 to 16) [Rpt./2] .

803. Clinical Clerkship (6 to 9)

815. Subspecialty
   b. The Dying Patient (1 to 6) [Rpt./1]
   c. Alcoholism: A Community Health Problem (3) [Rpt./1] I II Field trips.
   d. Community Health Problems (6 to 12)
   g. Community Geriatrics (3 to 12) [Rpt./12 units] Field trips. Consult department before enrolling.

891. Preceptorship
   a. Primary Care (6 to 12)
   b. Family Medicine (3 to 12) P, 4th year medical student. Consult department before enrolling.
   f. Clinical Preceptorship in International Health (6 to 12)

896. Seminar
   a. International Health (3) S Open to health majors only
   b. * Epidemiologic Methods (3) I II
   c. Approaches to Managing Behavior Problems of Children and Adolescents (2)
   e. * Occupational and Environmental Health (1 to 3)
   f. The Doctor-Patient Relationship (2)
   u. * Current issues in Health Services (2)
   cc. * Community and International Nutrition (1 to 3) II (identical with N.F.S. 596cc)
   ss. * Tropical Disease Problems (2)
   yy. * Basic Principles of Epidemiology (3) [Rpt./1]

*Available as both 596 and 896.
Internal Medicine


Assistant Professors Frederick Ahmann, John W. Bloom, Marlene Bluestein, Keith Comess, Timothy C. Fagan, Paul E. Fenster, Michael Habib, Ronald C. Hansen, Shoel-Kuen Huang, Frederick Kogan, Murray Korc, Stewart Levine, Thomas Miller, Charles Otto, John Palmer, Stuart E. Quan, Paul Rutala, Arthur B. Sanders, Brian Y. Shon, Gayle A. Traver, David B. VanWyck

500. Research (2 to 16) [ Rpt./1]

555. Cancer Biology (3) II 1986-87 (Identical with Micr. 555)

800. Research (2 to 16) [ Rpt./1]

803. Clinical Clerkship (12)

810. Clerkship
   a. Internal Medicine (6)
   b. Ambulatory Diagnosis and Therapeutics (1 to 18)
   c. Geriatrics and General Medicine Extended Care (6) [ Rpt./1] P, 803.

815. Subspecialty
   a. Clinical Cardiology Elective (6)
   b. Clinical Dermatology (1 to 6)
   c. Endocrinology (6)
   d. Clinical Gastroenterology (6)
   e. Hematology-Oncology (6)
   f. Immunology, Arthritis and Allergy (6)
   g. Infectious Diseases (1 to 6)
   h. Pulmonary Diseases (1 to 6)
   j. Pulmonary Laboratory and Consultation Service (3 to 6)
   k. Nephrology, Renal Diseases (6)
   l. Clinical Allergy (1 to 6) (Identical with Ped. 815l)
   m. Medical Subspecialities (1 to 18) [ Rpt.]
   n. Medical Medicine and Rehabilitation (4 to 6) [ Rpt./1] CDT P, 3rd or 4th yr. med school.
   p. Critical Care Medicine (1 to 18) (Identical with Anes. 815p)
   r. Neurological and Neuromuscular Disorders (3 to 6) P, 803. (Identical with Neur. 815r)
   s. Arthritis and Clinical Immunology (3 to 18) P, 803.

891. Preceptorship
   a. General Medicine and/or Subspecialties (1 to 18) [ Rpt./2]

Microbiology and Immunology

See Microbiology and Immunology elsewhere in this catalog.

Neurology

Professors Peggy Ferry (Pediatrics), William A. Sibley
Associate Professor Colin R. Bamford, Acting Head

495. Colloquium
   b. Introduction to Neurosciences II (2) GC (Identical with Med. 495b, which is home)
230 DEPARTMENTS AND COURSES OF INSTRUCTION

495. Colloquium
   b. Introduction to Neurosciences II (2) GC (Identical with Med. 495b, which is home)

500. Research (2 to 16) [ Rpt./1]

800. Research (1 to 12) [ Rpt./1]

803. Clinical Clerkship (3 to 6).

810. Clerkship
   a. Neurology (3 to 6).

815. Subspecialty
   r. Neurological and Neuromuscular Disorders (3 to 6) (Identical with I.Med. 815r, which is home)

891. Preceptorship
   a. Neurology (1 to 18) [ Rpt./2]

Obstetrics — Gynecology

Professors C. D. Christian, Head, Jack Pearson, Lewis Shenker
Associate Professors Diane S. Fordney, William C. Scott, Louis Weinstein
Assistant Professors Herbert E. Pollock, Kathryn Reed, Sheldon Weiner

800. Research (1 to 18) [ Rpt./1]

803. Clinical Clerkship (6 to 9)

810. Clerkship
   a. Preparation for Practice (1 to 18)

891. Preceptorship
   a. Obstetrics and Gynecology (1 to 18)
   b. Gynecology-Endocrinology (6)

Ophthalmology

800. Research (6 to 18) I II

815. Subspecialty
   a. Ophthalmology (3 to 6)

891. Preceptorship

Pathology

Associate Professors James M. Byers, III, Anna R. Graham, Thomas M. Grogan, Mary Jane Hicks, Douglas H. McKelvie, Richard E. Sobonya
Assistant Professors Ronald Schifman, Catherine M. Spier, Karen K. Steinbronn

489. Introduction to Forensic Science: Pathology, Anthropology, Toxicology and Law (2) GC I II
   Opportunity for the criminal investigator and attorney with a background in forensic pathology to
   better understand the results of trauma, toxic substances and environmental catastrophes.
   Taught off campus only.

801. General and Systemic Pathology (10) I II

810. Clerkship
   a. Anatomic Pathology (1 to 18)
   b. Clinical Pathology (1 to 18)
   c. Special Topics (1 to 18) [ Rpt.]. P, 801.
891. Preceptorship
a. Pathology (1 to 18) [Rpt./2]

Pediatrics


Associate Professors William T. Boyce, Sergio A. Bustamante, John J. Hutter, Stanley M. Lee, Michael J. Schumacher, Elsa Sell


800. Research (1 to 18)

803. Clinical Clerkship (6 to 9)

810. Clerkship
a. Externship in Inpatient Pediatrics (6) P, 803
b. Pediatric Care in a Cross-Cultural Setting (6)
c. Inpatient Pediatrics (6)

811. Subinternship
a. Ambulatory Pediatrics (1 to 18)
b. Behavioral and Developmental Pediatrics (1 to 18)
c. Adolescent Medicine (6) [Rpt./1] Yr. P, 803

815. Subspeciality
a. Advanced Neonatology (6)
b. Pediatric Infectious Diseases (6)
c. Cardiac Ultrasound Echo and Doppler (4 to 6)
d. Pediatric Cardiology (6)
e. Pediatric Neurology (6)
f. Pediatric Hematology/Oncology (6)
g. Poison Center (4 to 6) P, 803
h. Pediatric Clinical Pharmacology (1 to 12) [Rpt./1]

891. Preceptorship
a. Pediatrics (1 to 18)
b. Preparation for Practice (1 to 18)

Pharmacology

See Pharmacology elsewhere in this catalog. Toxicology courses are listed under Pharmacology and Toxicology.

Physiology

See Physiology elsewhere in this catalog.

Psychiatry


Associate Professors Diane S. Fordney (Obstetrics and Gynecology), Alfred Kasznia, Henry I. Yamamura (Pharmacology)

Assistant Professors Peter J. Attarian (Family and Community Medicine), Shirley N. Fahey, Milton Frank, Russell D. Martin, Rebecca L. Potter
232 DEPARTMENTS AND COURSES OF INSTRUCTION

495. Colloquium
   b. Introduction to Neurosciences II (2) GC (Identical with Med. 495b, which is home)

800. Research (1 to 12)

803. Clinical Clerkship (6 to 9) [ Rpt./1 ]

810. Clerkship
   a. Clinical and Community Psychiatry (1 to 18)
   b. Child Psychiatry (1 to 18).

815. Subspecialty

891. Preceptorship
   a. Psychiatry (1 to 18) [ Rpt./2 ] P, 803.

Radiology


Associate Professors John C. Bjelland, George T. Bowden, Tom Cetas, William G. Connor, Robert Henry, Tim Hunter, Gerald Pond, Jeffrey Trent, Bryan Westerman

Assistant Professors Raymond Carmody, Mark Chernin, Anne Cress, John D. Newell, Del Steinbronn, Jeffrey F. Williamson, Peter Yang

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, Intro. bio. and chem.

551. Environmental Carcinogenesis (3) II 1986-87 See 851 for description. (Identical with Micr. 551)

555. Cancer Biology (3) II 1986-87 (Identical with Micr. 555)

596. Seminar
   h. Control of Proliferation in Animal Cells (1 to 2) P, permission of instructor. (Identical with Micr. 596h)

800. Research (1 to 6) [ Rpt./1 ]

815. Subspecialty
   a. Diagnostic Radiology (6)
   b. Nuclear Medicine (1 to 6)
   c. Radiation Oncology (1 to 16)

851. Environmental Carcinogenesis (3) II 1986-87 Phenomenological and mechanistic aspects of cancer etiology as induced by physical and chemical agents in our environment, with special emphasis on possible molecular and cellular mechanisms involved in cancer etiology. P, consult department before enrolling.

891. Preceptorship
   a. Radiology (1 to 18) [ Rpt./1 ] P, 815a

896. Seminar
   h. Control of Proliferation in Animal Cells (1 to 2) (Identical with Micr. 896h)

Surgery


Assistant Professors Robert B. Dzioba, Robert W. Emery, J. David Gibeault, Robert P. Iacono, Kenneth V. Iserson, Steven M. Joyce, Keith R. Kaback, Kenneth E. McIntyre, Arthur B. Sanders, John B. Sullivan

800. Research (1 to 12) P, 803.

803. Clinical Clerkship (6 to 9)

807. Specialty Clerkship (3) P, basic science courses.

810. Clerkship
   a. General Surgery (6)

815. Subspecialty
   a. Urinary Stone Disease (6)
   b. Cardiothoracic Surgery (6)
   c. Neurosurgery (6)
   d. Surgical and Medical Problems in Fluid and Electrolyte Balance (1 to 3) [Rpt./1]
   e. Urology (6)
   f. Orthopedics (3)
   g. Cardiovascular Physiology and Research (1 to 12)
   h. Lymphvascular System in Health and Disease (6 to 12)
   j. Otorhinolaryngology (3)
   k. Sports Medicine (Section of Orthopedic Surgery) (1 to 6) [Rpt./1]
   l. Orthopedic Bioengineering (3 to 6) P, Nine weeks of surgery clerkship, 803 and/or 807
   m. Trauma (3 to 6)
   r. Clinical Experience in Rehabilitation Medicine (1 to 4)
   t. Emergency Medicine (3 to 12)

891. Preceptorship
   a. Surgery and Subspecialties (1 to 18) [Rpt./3]

MEDIEVAL STUDIES

Committee on Medieval Studies (Graduate)

Professors Sigmund Eisner (English), Chairperson, John Boe (Music)
Associate Professors Jonathan Beck (French and Italian), Alan E. Bernstein (History),
Richard C. Jensen (Classics), Stephen H. West (Oriental Studies)

The Graduate Committee on Medieval Studies does not offer any 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 committee in advance.

The program of study for the Doctor of Philosophy minor in medieval studies requires:
a minimum of fifteen hours in graduate course work (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 (for non-music majors), or philosophy (for non-philosophy majors).

Related Courses

Refer to the appropriate department for course descriptions and unit values. Courses
which are applicable to the program are Art. 412a-412b, 413a, 512, 596c; Clas. 401; Engl. 426,
427, 527a-527b, 596a; Ger. 400a, 511a-511b, 520a-520b, 696a; Hist. 405a-405b, 406, 407,
408; Mus. 500q, 530, Fren. 402, 422, 520a-520b, 696a, 696c; Ital. 422, 435a-435b, 696a;
Port. 422, 696a; Span. 400a, 422, 540, 541, 620, 696a, 696b; Russ. 583, 685.

METALLURGICAL ENGINEERING
(See Materials Science and Engineering)
METEOROLOGY
(See Atmospheric Sciences)

MICROBIOLOGY
(See Microbiology and Immunology)

MICROBIOLOGY AND IMMUNOLOGY

Professors John Spizizen, Head, Peter Bartels (Optical Sciences), Harris Bernstein, Charles P. Gerba (Nutrition and Food Science), Junetsu Ito, Wayburn S. Jeter (Pharmacology and Toxicology), Rein Kilkson (Physics), Peter P. Ludovici (Emeritus), William Meinke, Neil Mendelson (Molecular and Cellular Biology), Raymond Nagle (Pathology), George B. Olson, George Ray (Pathology), Diane Russell (Pharmacology), Kenneth Ryan (Pathology), Irving Yall (Emeritus)

Associate Professors Homer Bloss (Plant Pathology), Timothy Bowden (Radiology), Robert J. Janssen, Lynn Joens (Veterinary Sciences), David Lucas, Frank Meyskens (Internal Medicine), Ian Pepper (Soils, Water and Engineering), Eskild Petersen (Internal Medicine), Jack Pinnas (Internal Medicine), Norval A. Sinclair, James T. Siński, J. Glenn Songer (Veterinary Sciences), Charles Sterling (Veterinary Sciences)

Assistant Professors Richard Friedman, Mary Hendrix (Anatomy), Alan Howarth (Plant Pathology), Ruthann Kibler

The graduate program in microbiology and immunology has three major areas of emphasis: (1) molecular, genetic and physiological microbiology, (2) environmental, pathogenic and industrial microbiology, and (3) immunology. The research systems used include viruses, viroids, bacteria, bacterial plasmids, fungi, protozoan, parasites, cell and tissue culture, and animal models standardly used in immunological studies.

Master of Science and Doctor of Philosophy degrees with a major in microbiology are offered by a program whose faculty include members from a variety of different departments. The Microbiology Specialist degree is also offered.

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.

403R. Biology of Animal Parasites (3) GC I (Identical with V.Sc. 403R)


417L. Advanced Laboratory Techniques (2) GC II Instrumentation and technology in microbial physiology and immunology. P, 417R, 419.

419. Introductory Immunology (3) GC I Basic concepts of the immune system. Presentation of the roles antigen, immunoglobulins, complement, lymphokines and types of immune cells play in generalization of humoral and cell-mediated immunity. P, 217, Chem. 241b, 243b. (Identical with V.Sc. 419)

420R. Pathogenic Microbiology (3) GC II Characteristics, isolation and identification of microorganisms pathogenic for humans and other animals. P, 217, Chem. 241b, 243b. (Identical with V.Sc. 420R)

420L. Pathogenic Microbiology Laboratory (2) GC II Laboratory methods in pathogenic microbiology. P, CR 420R (Identical with V.Sc. 420L)

423R. General Pathology (3) GC II (Identical with V.Sc. 423R)

423L General Pathology Laboratory (1) GC II (Identical with V.Sc. 423L)

427L. General Mycology Laboratory (2) GC I General mycology lab., with emphasis on the microfungi. P, CR 327R.

428R. Advanced Microbial Genetics (3) GC II (Identical with M.C.B. 428R)

428L. Advanced Microbial Genetics Laboratory (2) GC I (Identical with M.C.B. 428L)


430. Introduction to Biophysics (2) GC I (Identical with Phys. 430)

435. Soil Microbiology (3) GC I (Identical with S.W.435)


450. Medical Mycology (4) GC II The isolation and identification of fungi of medical importance. 2R, 6L. P, 217. (Identical with V.Sc. 450)

451. Diagnosis and Control of Plant Diseases (3) GC I (Identical with Pl.P. 451)

470. Food Microbiology and Sanitation (3) GC II (Identical with N.F.S. 470)

471. Food Microbiology and Sanitation Laboratory (2) GC II 1986-87 (Identical with N.F.S. 471)

501. Medical Microbiology (6) I 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 lab. experiments. P, Ecol. 101b, Chem. 241b, Bioc. 501.

530. Biophysical Theory (2) II (Identical with Phys. 530)

550. Molecular Mechanisms of Microbial Pathogenesis (3) II 1986-87 Review of current concepts in specific areas of microbial pathogenesis, including action of exo- and endotoxins, cell surface interactions, phagocytosis and host microbicidal functions. P, Bioc. 460.

551. Environmental Carcinogenesis (3) II 1986-87 (Identical with Radi. 551)

555. Cancer Biology (3) II 1986-87 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, I.Med. 555, and Radi. 555)


561. Immunobiology (3) II 1986-87 Cells and cellular events involved in humoral and cell-mediated immune responses; morphologic, physiologic and biochemical characterizations of the lymphoreticular system. P, Bioc. 462a-462b.

570. Molecular Genetics (3) I 1985-86 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.


577. Advanced Microbial Physiology (2) I 1985-86 Studies of metabolic pathways of selected microorganisms with an emphasis on industrial applications. P, 417R.


596. Seminar
a. Current Problems in Molecular Biophysics (1) I II (Identical with Phys. 596a, which is home)
h. Control of Proliferation in Animal Cells (1 to 2) I (Identical with Radi. 596b, which is home)

630. Immunology of Infectious Disease (4) II 1986-87 Correlation of the roles played by components of humoral and cell-mediated immunity (CMI) in infectious disease. Methods for monitoring changes in humoral and CMI during the disease process. 2R, 6L. P, 419, Bioc. 480. (Identical with V.Sc. 630)
672. Food Safety (2) I 1985-86 (Identical with N.F.S. 672)


695. Colloquium
   a. Readings in Microbiology (1) [Rpt.] I II
   b. Immunopathology (1) I II
   c. Molecular Genetics of Microorganisms (1) I II
   d. Molecular and Cellular Immunology (1) I II
   e. Tumor Virology (1) I II
   f. Host-Parasite Interactions (1) I II

696. Seminar
   a. Research Seminar (1) [Rpt.] I II

801. Medical Microbiology (6)

851. Environmental Carcinogenesis (3) II 1986-87 (Identical with Radi. 851)

896. Seminar
   h. Control of Proliferation in Animal Cells (1 to 2) I (Identical with Radi. 896h, which is home.)

MINERAL ECONOMICS
(See Mining and Geological Engineering)

MINING AND GEOLOGICAL ENGINEERING

Professors Ian W. Farmer, DeVerle P. Harris, Y. C. Kim, Richard Newcomb, William C. Peters (Emeritus), Michael Rieber
Associate Professors Charles E. Glass, Head, Jaak J. K. Daemen
Assistant Professors Satya Harpalani, Pinnaduwa Kulatilake

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in mining engineering, geological 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 an emerging field of applied economics encompassing the interface of minerals engineering and earth science with the business of mineral production and the welfare of society.

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.

Students working toward the Master of Science degree in either mining engineering or geological 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.

A

Geological Engineering

407. Photogeology (3) GC II Use of aerial photographs in geologic mapping. 1R, 6L. P, Geos. 221. (Identical with Geos. 407) Glass

410. Mining Geology (2) GC II Collection, analysis, and utilization of geologic data in the production of minerals; includes surface and underground mapping. 6L. P, Geos. 412.

420. Geophysical Exploration: Potential Field Methods (4) GC I (Identical with Geos. 420)

422. Geophysical Engineering (3) GC I Applied geophysics as employed in engineering problems, including geophysical methods and interpretation of results in mineral exploration, earthquake studies, and site examination. P, Phys. 103b, Math. 223.

425. Geotechnical Investigations (3) GC II Investigation and analysis of geologic factors in the design and construction of engineering projects. 1R, 6L. P, 424.

427. Geomechanics (3) GC I (Identical with Mn.E. 427)

428. Ore Search (3) GC I Analysis of guides and techniques leading to location and delimitation of ore bodies. Field trips. 2R, 3L. P, Geos. 303, CR 420 or 422.

438. Design of Exploration Programs (3) GC II Geologic and economic principles applied to the design of mineral exploration programs and to the evaluation and development of prospects. P, 428.

460. Health Hazards in the Mine Environment (2) GC II 1985-86 (Identical with Mn.E. 460)

461. Accident Prevention in the Mine Environment (2) GC II 1986-87 (Identical with Mn.E. 461)

460a-460b. Estimation of Mineral Resources by Quantitative Methods (3-3) 1985-86 (Identical with Mn.Ec. 660a-660b)

507. Applied Multispectral Imagery (3) II Application to mineral exploration, engineering geology, groundwater location, and pollution monitoring. 6L. P, 407. (Identical with Geos. 507) Glass

527. Fundamentals of Geomechanics (4) II (Identical with Mn.E. 527)

528. Subsurface Exploration Methods (3) I 1986-87 Advanced geological and engineering methods applied to the location and delimitation of deep ore bodies from mine workings and boreholes. 1R, 6L. P, 428.

538. Simulation Gaming in Exploration (3) I 1985-86 Integrated approach to ore search involving modeling, decision making, and sequential field operations. 1R, 6L. P, 438.


649. Probabilistic Methods in Geotechnical Engineering (3) II 1985-86. (Identical with C.E. 649)

649. Probabilistic Methods in Geotechnical Engineering (3) II 1985-86. (Identical with C.E. 649)

696. Seminar
a. Research Seminar (1 to 3) [Rpt.] I II

Mineral Economics

418. Mine Investment Analysis (3) GC II (Identical with Mn.E. 418)

550. Economics of the Metal Industries (3) II Reserves, resources, and major deposits, production technologies, market structure, industrial organization, consumption trends, recycling, foreign trade, and geopolitics of selected industries. P, A.Ec. 504.

560. Economics of the Nonmetals (3) II 1986-87 Technology of production, raw materials, uses and markets, industrial organization, market structure, economics of production, pricing, and marketing practices for nonmetallic minerals. P, A.Ec. 504.

584. Economics of Coal, Nuclear, and Alternative Energy Sources (3) I Reserves and resources, economics of production, utilization and conversion, externals, market structure, policy issues for alternative energy sources such as oil shale, tar sands, coal gasification, and solar. P, A.Ec. 504.

586. Economics of Petroleum and Natural Gas (3) I Reserves and resources of petroleum and natural gas, production technology, market structure, industrial organization, pricing, competitive behavior, consumption trends, and policy issues. P, A.Ec. 504.


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.

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 A.Ec. 504.


696. Seminar
a. Research Seminar (1 to 3) [Rpt./3 units] I II
b. Advanced Topics in Mineral Evaluation and Risk Analysis (1 to 3) [Rpt./3 units] I II
c. Mineral and Energy Policy Analysis (1 to 3) [Rpt./3 units] I II
d. Advanced Mineral Commodity Analysis (1 to 3) [Rpt./3 units] I II
e. Topics in Mineral and Energy Supply (1 to 3) [Rpt./3 units] I II
f. Decision Analysis and Operations Research in Mineral Exploration (1 to 3) [Rpt./3 units] I II
g. Process Analysis and Costing (1 to 3) [Rpt./3 units] I II

Mining Engineering

401. Analysis of Mine Operations (2) GC I Use of Operations Research principles and techniques to analyze production, distribution and valuation problems in mine operations, with emphasis on deterministic cases. 1R, 3L, P, 302. Kim

418. Mine Investment Analysis (3) GC 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 Mn.Ec. 418)
420. **Mine Design** (3) GC II Design of a modern mine; feasibility study, reserve estimation, mine planning, hoisting, compressed-air distribution and drainage. 2R, 3L. Field trips. P, 304, 321, 430, or CR. Kim

427. **Geomechanics** (3) GC 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; reinforcement design. 2R, 3L. P, C.E. 217, Geos. 221. (Identical with G.En. 427) Daemen

437. **Geomechanics Applications in Mining** (2) GC II 1986-87 Application of geomechanic principles to geotechnical mining problems: rock excavation, subsidence, mine pillar design, tabular excavations, rock bursts. All-day field trip. P, 427.

447. **Geomechanics Applications in Construction** (2) GC II 1985-86 Application of geomechanic principles to geotechnical engineering problems: tunneling and underground construction, rock slope engineering, foundations on rock. All-day field trip. P, 427.

450. **Health Hazards in the Mine Environment** (2) GC II 1985-86 Case histories in recognition, evaluation and control of health hazards in mine environments. All-day field trip. P, 325 or consult dept. before enrolling. (Identical with M.S.E. 460 and G.En. 460)

461. **Accident Prevention in the Mine Environment** (2) GC II 1986-87 Concepts and case histories in recognition, evaluation and control of occupational safety hazards common to the mine environment. All-day field trip. P, 325 or consult dept. before enrolling. (Identical with M.S.E. 461 and G.En. 461)

500. **Economics of Mineral Resource Development and Production** (4) I (Identical with Mn.Ec. 500)

501. **Analysis of Management Decisions** (3) II 1985-86 Use of O. R. principles and advanced O. R. techniques to evaluate management decision problems in the mineral industry, with emphasis on probabilistic cases. P, 302, 401. Kim

527. **Fundamentals of Geomechanics** (4) II Mechanical behavior of geological materials: stress and strain analysis; friction; elasticity, strength and failure; discontinuity slip. Laboratory testing and applications to selected mining or geological problems. 3R, 3L. P, 427 or C.E. 340, Geos. 221. (Identical with G.En. 527) Daemen

622a-622b. **Advanced Design of Mining Systems** (3-3) 1985-86 Use of geostatistics, operations research, mining economics, and computer techniques in the analysis, design, and operation of modern mining systems. 2R, 3L. P, 302, 401, 420, S.I.E. 272.


696. **Seminar**
   a. Research Seminar (1 to 3) [ Rpt. ] II

**MOLECULAR AND CELLULAR BIOLOGY**

Professors H. Vasken Aposhian, Wayne R. Ferris, Mac E. Hadley, Richard B. Hallick (Biochemistry), Konrad Keck, Neil H. Mendelson, David W. Mount, James W. O'Leary, Peter E. Pickens, Diane H. Russell (Pharmacology), Nobuyoshi Shimizu

Associate Professors Thomas J. Lindell, Acting Head, Hans J. Bohnert (Biochemistry), Don P. Bourque (Biochemistry), Wah Chiu (Biochemistry), William J. Grimes (Biochemistry), Jennifer D. Hall, Martinez J. Hewlett, Kaoru Matsuda, Frank L. Meyskens (Internal Medicine)

Assistant Professors Danny L. Brower, James F. Deatherage (Biochemistry), Carol L. Dieckmann (Biochemistry), John W. Little (Biochemistry)

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 cellular and developmental biology and molecular biology. Applicants for admission should be prepared in chemistry, physics, and mathematics and must submit scores on the aptitude test 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, structure and function of nucleic acids, developmental biology of higher plants, plant molecular biology, molecular genetics, invertebrate developmental biology, environmental plant physiology, and gene transfer systems for mammalian cells. A listing of the faculty of the department and their research interests can be obtained from the department on request. A thesis is required for the master’s degree.

404. Contemporary Biology and Human Affairs (3) GC II Advances in biomedical research will be reviewed and their ethical, social and legal implications discussed. P, one course in bioc. or bio.; botany not acceptable.

410a-410b. Advanced Cell Biology (3-3) GC Regulation at the cellular and molecular levels; gene expression; nature, function, and integration of organelles and ultrastructural components of the cell. P, 103 (for majors), Chem. 243a or 480a.

412. Radiotopes In Biology (3) GC I Advanced techniques in the application of radioactive tracers to problems of molecular biology; kinetics of labeling, fractionation procedures; detection systems and processing of data. 2R, 3L. P, Chem. 103b, 104b, Phys. 102a-102b.

413. Advanced Cell Biology Laboratory (2) GC I Modern lab. techniques for genetic and molecular analyses of mammalian cells in culture. 6L. P, CR 415.


428R. Advanced Microbial Genetics (3) GC II Modern concepts of microbial genetics: basic genetic theory, the molecular architecture, biosynthesis and genetic regulation of bacterial cell structure, control of growth and cell division. P, 103, Micr. 328, Ecol. 320 or 321. (Identical with Ecol. 428R and Micr. 428R)

428L. Advanced Microbial Genetics Laboratory (2) GC I Individual research projects within the framework of microbial genetics, with emphasis on the genetic system of Bacillus subtilis. (Identical with Ecol. 428L and Micr. 428L)

456. Developmental Biology (4) GC I Descriptive aspects of development. 3R, 3L. P, 103. (Identical with Anat. 456)


460. Plant Physiology (4) GC I Introduction to water relations, photosynthesis, respiration, growth and development of higher plants. 3R, 3L. P, Chem. 241a, 243a. (Identical with Ecol. 460)


463. Introduction to Neurobiology (3) GC I Physiology and anatomy of invertebrate and vertebrate nervous systems. P, eight units of bio.

464aR-464bR. Human Physiology (3-3) GC (Identical with Ecol. 464aR-464bR)

464aL-464bL. Human Physiology Laboratory (1-1) GC (Identical with Ecol. 464aL-464bL)

465. Advanced Neurobiology (2) GC II Selected topics in current neuroethological research on vertebrate and invertebrate nervous systems. P, 463, or consult department before enrolling.

467R. Endocrinology (3) GC II (Identical with Anat. 467R)

467L. Endocrinology Laboratory (1) GC II (Identical with Anat. 467L)
473. **Recombinant DNA Techniques** (3) GC II Relevant techniques for the isolation, purification and cloning of genes in *E. Coli* hosts. Cloned DNA will be characterized by restriction mapping and hybridization techniques. 1R, 6L. Consult department before enrolling. P, 410a, Bioc. 462a. (Identical with Bioc. 473)

514. **Supramolecular Structure** (2) II 1986-87 Application of diffraction techniques in the study of structure and function of biological macromolecules.

530. **Current Topics in Eucaryotic Gene Expression** (3) II 1986-87 Detailed examination of current literature in selected areas of eucaryotic molecular biology. P, 568b or consult dept. before enrolling.

540. **Advances in Mammalian Cell Biology** (2) [ Rpt./2] II Selected topics in mammalian cell structure and functions and its genetic control. P, 415 or consult dept. before enrolling.

550. **Topics in Pigment Cell Biology** (2) I (Identical with Anat. 550)

558. **Advanced Subjects in Endocrinology** (2) [ Rpt.] I (Identical with Anat. 558)

562. **Plant Intermediary Metabolism** (3) II 1986-87 Selected topics in plant metabolism and photosynthesis. P, 460. (Identical with PL.S. 562)

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. (Identical with WS.M. 563)

564. **Plant Growth and Development** (3) II 1985-86 Selected topics in growth and development. P, 460. (Identical with PL.S. 564)

568a-568b. **Nucleic Acids** (3-3) 1985-86 (Identical with Bioc. 568a-568b)

570. **Molecular Biology of the Cell Membrane** (3) I 1986-87 (Identical with Bioc. 570)

595. **Colloquium**
   a. **Topics in Molecular Biology** (1) [ Rpt./1] II Open to majors only.
   b. **Topics in Electron Microscopy** (2) [ Rpt./2] II 1985-86 P, Math. 125b, Phys. 102b or 103b. (Identical with Bioc. 595b)

612. **Principles of Electron Microscopy** (4) I Principles and practice of electron microscopy; specimen preparation, micrograph interpretation, and operation and maintenance of electron microscopes. 2R, 6L.

696. **Seminar**
   a. **Recent Research** (1) [ Rpt./3] II

761. **Methods in Molecular and Cellular Biology** (3) I II Current techniques for qualitative and quantitative studies. 9L. Open to majors only.

**MOLECULAR AND MEDICAL MICROBIOLOGY**
*(See Microbiology and Immunology)*

**MOLECULAR BIOLOGY**
*(See Molecular and Cellular Biology)*

**MUSIC**


Associate Professors Terry J. Barham, Koste A. Belcheff, Gary D. Cook, Elizabeth Thompson Ervin, John R. Fitch, Jeffrey Haskell, Keith M. Johnson, James Keene, Rodney M. Mercado, Daniel Sullivan, Charles West

Assistant Professors Paula Fan, J. Timothy Kolosick, Carrol McLaughlin, Thomas Patterson, Jeffrey Showell
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, music education, and performance. With the doctoral performance major, concentrations are available in bassoon, cello, clarinet, flute, horn, harp, oboe, organ, percussion, piano, saxophone, string bass, trombone, trumpet, viola, violin, and voice. The school also offers a program leading to the Doctor of Philosophy degree with a major in music theory. All candidates for admission to the Ph.D. program with a major in music theory will show evidence of satisfactory competencies in their fields 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. In 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. 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.

410a-410b. Pedagogy (2-2) GC Study of methods and repertory suitable for studio teaching. Open to mus. majors in their major performance area only.

422. Jazz Arranging (2) GC II Class instruction and practice in writing arrangements for small jazz combos, rock groups, stage bands, and pop-vocal combinations; detailed study of jazz instrumental practices and problems. Open to majors only or by permission of instructor. P, 200r, 201j, 220b.


430a-430b. Art Song Repertory (2-2) GC 1986-87 Class performance of representative selections from the standard repertory of German, Italian, French, Russian and English language art songs; problems of accompaniment, interpretation, style and ensemble. Registration restricted to singers and pianists. Open to majors only.

431a-431b. History of the Opera (3-3) GC 1985-86 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.

432. Music in World Cultures (3) GC II Overview of nonwestern musics in selected world cultures.

433a-433b. Piano Literature (3-3) GC Historical and stylistic study of keyboard literature, instruments and performance practices. 433a: Baroque through the early Romantic periods. 433b: Mid-Romantic through the Contemporary periods. P, 285-P. 433a is not prerequisite to 433b.

434. History and Literature of Guitar. (3) GC II 1985-86 In-depth study of the evolution of the guitar, lute, and vihuela, including repertoire, style periods, and composers. Open to majors only.

435. Choral Literature and Techniques (2) GC II Choral selections with interpretation techniques; for choral conductors and music educators. P, 220b, 330b.

441a-441b. Introduction to Electronic Music (3-3) GC [Rpt./1] Survey of the historical, theoretical and technical aspects of electronic music as applied to the composition of music in the contemporary idiom, including actual lab. applications.

450. Teaching Music in the Elementary School (3) GC I Role of the music specialist in the elementary school; materials, activities, and observation of demonstration teaching as they relate to a comprehensive music curriculum and qualitatively musical experiences for children in grades K-6.
451. Teaching Junior High School Music (3) GC II Objectives, curriculum, material, and activities for teaching general, choral and instrumental music in the junior high school. Observation and critiqued field experience.

520. 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.

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. Open to majors only.

530. Music in the Renaissance (3) II 1985-86 Vocal and instrumental genres from Dufay through Palestrina. Open to majors only.

531. Music in the Baroque (3) I 1985-86 The age of the basso-continuo; instrumental and vocal genres from Monteverdi through J. S. Bach. Open to majors only.

532. Music in the Classical Period (3) I 1986-87 The Viennese classical tradition from its origins to Beethoven. Open to majors only.

533. Music of the Twentieth Century (3) II 1986-87 Contemporary idiom in music; study of genres, styles, and techniques from post-Romanticism to the present. Open to majors only.


537. Survey of Early Music (3) S Intensive survey of music history from Gregorian chant to the late Baroque. Open to majors only.


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.

600. Introduction to Graduate Study in Music (3) II Bibliographical materials; research resources, techniques, and problems directed toward grad. study in music. Required of all doctoral candidates in music. (Identical with Li.S. 600)

620a-620b. History of Speculative Theory (3-3) 1985-86 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 1986-87 Study of the philosophies, procedures, techniques, and materials used in teaching theory at the college level.


630. The Music of Bach (3) II 1986-87

631. The Music of Mozart (3) II 1985-86


650. Foundations and Principles of Music Education (3) I History and philosophy of music education in the public schools, with emphasis on the basic concepts needed for effective teaching in the field of music, curriculum development and evaluation of the music program.

651. Curriculum Development in Music (3) II 1986-87 Principles and techniques of curriculum construction applied to the field of music.

652. The Administration of Music Education (3) II 1985-86 Financing, scheduling, selecting personnel and equipment, supervising instruction, maintaining desirable public relations, evaluating and administrating the total school music program in a school district, city, county, or state. P, 650.
The Music Cultures of Asia and Oceania (3) I 1986-87 Study of the musical styles and practices of Oceania and selected cultures in Asia, with emphasis on materials, instruments and ideas appropriate for classroom use.

Teaching Music in Higher Education (3) II Contemporary practices in planning, organizing, and evaluating learning experiences in music for college and university students. Open to music majors only.

Seminar
a. Music Education (1 to 6) I II
b. Musicology (1 to 6) I II
c. Music Theory (1 to 6) I II

Ensembles
All 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.

Large Conducted Ensembles (1)

a. Summer Band
b. Marching Band
c. Concert Band
d. Symphonic Band
e. Wind Ensemble
h. Summer Chorus
i. Symphonic Choir
j. University Singers

k. University-Community Chorus
l. Chamber Choir
m. Choraliers
o. Symphony Orchestra
p. Chamber Orchestra
q. Collegium Musicum
r. Jazz Ensemble

Coached Ensembles (1) Offering chamber music experience; designed to develop musical independence.

a. Accompanying
b. Brass Ensemble
c. Percussion Ensemble
d. Guitar Ensemble
e. Jazz Combo
f. Saxophone Ensemble
g. String Ensemble
h. Woodwind Ensemble

Small Conducted Ensembles (1)

a. Brass Choir
b. Contemporary Ensemble
c. Clarinet Choir
d. Musical Theatre
e. Pep Band
f. Flute Choir

Opera Theatre (1 to 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. May also include operatic staging techniques. P, four units of 405 or permission of the School of Music.

Advanced Composition (2 to 6) I II [Rpt.] Individual projects in composition. Open to theory and composition majors only.

Performance Studies: Individual and Group Instruction
All of the courses listed below are offered both first and second semester.

PIANO

580-P (1 to 2); 685-P, 785-P (1 to 4)

PIANO ACCOMPANYING

685-PA (1 to 4)
VOICE

580-V (1 to 2); 685-V, 785-V (1 to 4)

685-VC (1)

VOCAL COACHING

580-O (1 to 2); 685-O, 785-O (1 to 4)

ORGAN

685-Cg, 785-Cg (1 to 4)

CONDUCTING

STRING INSTRUMENTS

Violin
580-Vn (1 to 2); 685-Vn, 785-Vn (1 to 4)

Cello
580-C (1 to 2); 685-C, 785-C (1 to 4)

Viola
580-Va (1 to 2); 685-Va, 785-Va (1 to 4)

580-H (1 to 2); 685-H (1 to 4)

STRING BASS

580-Sb (1 to 2); 685-Sb, 785-Sb (1 to 4)

Harp
580-Hp (1 to 2); 685-Hp, 785-Hp (1 to 4)

Guitar
580-G (1 to 2); 685-G (1 to 4); 785-G (1 to 4)

HARPSCORD

WIND INSTRUMENTS

Clarinet
580-Cl (1 to 2); 685-Cl, 785-Cl (1 to 4)

Flute
580-F (1 to 2); 685-F, 785-F (1 to 4)

Oboe
580-Ob (1 to 2); 685-Ob, 785-Ob (1 to 4)

Bassoon
580-B (1 to 2); 685-B, 785-B (1 to 4)

Saxophone
580-S (1 to 2); 685-S, 785-S (1 to 4)

Trumpet
580-T (1 to 2); 685-T, 785-T (1 to 4)

Baritone
580-Ba (1 to 2); 685-Ba (1 to 4)

Tuba
580-Tu (1 to 2); 685-Tu (1 to 4)

PERCUSSION INSTRUMENTS

Percussion
580-Pc (1 to 2), 685-Pc, 785-Pc (1 to 4)

MUSIC EDUCATION
(See Music)

MUSICOLOGY
(See Music)

NATURAL RESOURCE RECREATION
(See Renewable Natural Resources)
NUCLEAR AND ENERGY ENGINEERING

Professors Robert L. Seale, Head, David L. Hetrick, Norman Hilberry, Richard L. Morse, Roy G. Post, Morton E. Wacks
Associate Professors W. Morris Farr, Rocco A. Fazzolare, William Filippone, Barry D. Ganapol, George W. Nelson
Assistant Professor Leland M. Montierth

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.

410. Energy System Design (3) GC II Modern techniques in synthesis and analysis are reviewed and applied to contemporary energy problems; economic evaluation, system modeling, optimization, and decision analysis. P, 348, A.M.E. 340a or Ch.E. 306.

415. Environmental Analysis of Energy Conversion (3) GC I Engineering analysis, assessment, and resolution of energy-environment interaction, with consideration of power plant siting, emissions, thermal effects, and waste management.

416. Radiation Health Physics and Safety (3) GC 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.

417. Nuclear Energy and Power (3) GC I Fundamentals of nuclear energy and radiation; engineering applications; the basic concepts of nuclear reactors and power systems. Designed for nonmajors.

420. Nuclear Engineering Laboratory (3) GC II Experimental techniques for determining various parameters in nuclear systems; experiments using the critical and subcritical reactors. P, 343.

435. Radiation Effects (3) GC 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, 343, CR M.S.E. 331R.

437. Introduction to Radioactive Waste Management (3) GC II Influence of public policy and waste physical form on the design criteria for waste management systems.

441. Contemporary Nuclear Power Systems (3) GC I Analysis of present nuclear power plants, with emphasis on design decisions as they affect performance of individual systems; comparison of different contemporary systems. P, 348 or 417.

445. Direct Energy Conversion (3) GC 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.

450. Introductory Nuclear Physics (3) GC II (Identical with Phys. 450 )

453. Air Conditioning Engineering (3) GC I (Identical with A.M.E. 453 )


456. Engineering System Simulation (3) GC 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, A.M.E. 340a or Ch.E. 306a; Math. 254.
463. Energy from Biomass (3) GC II (Identical with A.En. 463)

465. Current Problems in Energy and Power (1 to 4) [Rpt./6 units] GC II A multidisciplinary course with guest lecturers who are practicing professionals from the energy and power industry; a number of week-long, self-contained minicourses, with topics varying from year to year. (Identical with Ch.E. 465, and E.C.E. 465)

467. Solar Energy Engineering (3) GC I Energy analyses of solar collectors; selective surfaces; solar cells; energy storage; systems for solar heating and cooling; mechanical and electrical power; perspective. P, A.M.E. 340 or Ch.E. 306. (Identical with A.M.E. 467 and E.C.E. 467)

469. Energy Engineering Laboratory (3) GC I Basic measurements of energy quality, quantity, flow, and conversion. Includes active and passive solar as well as other alternative energy sources. 2R, 3L. P, 467 or CR. (Identical with A.M.E. 469)


530. Radiocchemistry and Radiation Detection (3) GC I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. 2R, 3L. P, Chem. 480b or Phys. 330. (Identical with Chem. 530)


541. 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, 441, 540.

544. Nonlinear Reactor Dynamics (3) II Nonlinear dynamics of nuclear reactors; shut-down mechanisms, inertial effects, nonlinear stability criteria, time-dependent neutron transport, neutron waves; and applications to pulsed reactors, start-up transients, reactor stability, and reactor safety. P, 454.

567. 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, A.M.E. 340a, 442. (Identical with A.M.E. 567, Ch.E. 567, and E.C.E. 567)

568. Photovoltaic Cells, Arrays and Systems (3) I (Identical with E.C.E. 568)

569. Energy Use: Analysis and Management (3) I Analysis of energy utilization; methods to evaluate and improve efficiency of energy. (Identical with Ch.E. 569 and E.C.E. 569)

583a-583b. Plasma Physics and Thermonuclear Theory (3-3) 583a: II Fundamentals of the theory of fully ionized plasmas, including wave phenomena and stability of plasma fluids; introduction to plasma kinetic theory. 583b: I Deposition of energy in thermonuclear plasmas; relaxation times and transport coefficients from Fokker-Planck theory; advanced subjects. P, 483b. (Identical with Phys. 583a-583b)


630. Fuel Cycles for Nuclear Reactors (3) II 1986-87 The design and analysis of fuel cycles for nuclear reactors; the processes and requirements for fuel element design and the limitations of fuel element performance to reactor design; economic factors in fuel cycles. P, 540.

642. Reactor Theory II (3) II Fundamental theory of heterogeneous reactors, integral transport, blackness theory, perturbation theory, and applications; temperature coefficient, changes in reactivity due to fission product accumulation, fuel consumption, and conversion. P, 540.

644. Advanced Reactor System Design and Analysis (3) I 1985-86 Application of design and analysis techniques to advanced nuclear reactor system concepts; utilizes current calculational techniques and system technology to arrive at integrated systems. P, 642.

645. 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, 343.

654. System Analysis of Nuclear Reactor Dynamics (3) II 1986-87 Selected topics in nuclear system dynamics, simulation and control; content varies. P, 454.
671. **Numerical Methods in Nuclear Engineering** (3) I 1986-87 Methods for numerical solution of differential and integral equations, with applications to computer modeling of nuclear reactors, power plants, fuel cycles, and basic processes in nuclear fission and fusion.

681a-681b. **Analytical Methods of Transport Theory** (3-3) 1985-86 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, 642, Math. 422a-422b.

685. **Inertial Confinement Controlled Fusion** (3) I Advanced topics in inertial confinement fusion, including energy absorption and transport phenomena, stability of spherical implosion systems, laser and charged particle drivers and reactor designs. P, 483b, 470b. (Identical with E.C.E. 685)

687. **Magnetic Confinement Controlled Fusion** (3) II Theory and design of magnetic fusion systems; instabilities; transport and reactor design considerations associated with linear magnetic fusion systems; Tokamaks and mirror machines. P, 483b; Phys. 415b, 470b. (Identical with E.C.E. 687)

**NURSING**

Professors Gladys E. Sorensen, Dean, Agnes M. Aamodt, Jan R. Atwood, Eleanor E. Bauwens, Pearl P. Coulter (Emerita), Ada Sue Hinshaw, Margarita A. Kay, Beverly A. McCord, Arlene M. Purt (Emerita)

Associate Professors Helen C. Chance, Evelyn M. DeWalt, Josephine R. Gibson, Mary E. Hazzard, Alice J. Longman, Lillian Lynch (Emerita), Betty J. McCracken, Merle Mishel, Alice L. Noyos, Jessie V. Pergin, Lois E. Prosser, Gayle A. Traver, Suzanne Van Ort, Mary J. Welty, Mary O. Wolanin (Emerita), Katherine J. Young

Assistant Professors Mary Alexander, J. Keenan Casteel, M. Antonia Heilman, Thelma Hostetter, Katherine A. Mason (Emerita), Barbara McClure, Carolyn Murdaugh, Dona Pardo, Linda Phillips, Pamela Reed, Karen Schepp, Rita Snyder-Halpern, Joyce Verran, Anne Woodtli

The College of Nursing offers programs leading to the Master of Science, Nursing Specialist, and Doctor of Philosophy degrees with a major in nursing.

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 degree program at the University of Arizona, (2) a current license to practice as a registered nurse in one of the fifty states, (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. Computer literacy recommended.

An automobile is essential since the clinical facilities are located throughout the Tucson area.

**Degrees**

**MASTER OF SCIENCE** — Concentrations are available in child, community health, gerontological, maternal-newborn, medical-surgical, and psychiatric-mental health nursing. Upon completion of the Master of Science program, the student will have met the following objectives: competence in a selected area of clinical nursing, competence in a functional area of nursing, knowledge in a related discipline, and ability to use principles of theory construction and research processes.

The program includes a minimum of 36 units of which no fewer than 24 units (including the thesis) must be in nursing. The remaining units may be selected from one or two related disciplines or may be distributed as six to nine units from the related discipline plus additional units in nursing. Students with a concentration in gerontological, maternal-newborn, or medical-surgical nursing must include one or more graduate courses in human physiology.
The time required for completion of degree requirements is at least two regular semesters plus one summer. Most students enroll for an additional semester. The sequence of nursing courses begins with the fall semester but a new student may begin non-nursing courses during the preceding summer if desired. Study on a part-time basis is possible. Concurrent with the nursing practicum offered each spring, students select preparation in either of the functional areas of administration or teaching.

**NURSING SPECIALIST** — For information concerning this degree program see Requirements for Specialist Degrees/Nursing Specialist elsewhere in this catalog.

**DOCTOR OF PHILOSOPHY** — Applicants must present evidence of the completion of a bachelor’s degree or both bachelor’s 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 of at least 3.00 or “B,” graduate grade-point average of 3.50, Graduate Record Examination scores of 1,100 on the quantitative and verbal portions of the aptitude test. In addition, applicants must submit references attesting to their potential as graduate students. A personal interview is encouraged. The program is strongly research-oriented.

- **482. Legal Implications in Nursing (3) GC I II** Overview of the nurse’s relationship with law, as a practicing nurse, and as an individual; exploration of roles from student to expanded practice, in the community, in the legislative process. Advanced degree credit available for non-Ph.D. majors only.

- **484. The Health Professions and the Social Sciences (3) GC I** Implications of concepts and theories from anthropology, psychology and sociology for health care. Advanced degree credit available for non-Ph.D. majors only.

- **487. Poverty and Health (3) GC 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 soc. sci. (Identical with Anth. 487 and F.C.M. 487)

- **488. School Nurse Practice (3) GC S** Analysis and application of nursing in school systems. Communication skills, teaching-learning principles for family, physical, psychological assessment. P, R.N.

- **495. Colloquium**
  a. **Bilingual Health Communication (3) GC II** (Identical with Anth. 495a, which is home.)

- **588. Clinical Anthropology (3) I II** Application of principles from anthropological theory to the actual practice of patient care, with emphasis on culture content of groups living in the greater Southwest. P, nine units of behavioral sci. (Identical with Anth. 588 and F.C.M. 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.

- **600a-600b-600c. Nursing Theory and Practice (3-3-3) Iit S** Maintenance, therapeutic and preventive nursing care of persons in various settings. Student elects practice in one area of nursing: (1) child; (2) community health; (3) gerontology; (4) maternal-newborn; (5) medical-surgical; (6) psychiatric-mental health. Laboratory is required.

- **602. Evaluation Process in Nursing (3) II** Development and use of models and tools for assessing nursing processes, programs and performances. Approaches to and psychological reactants of evaluation are explored.

- **620. The Administrative Process (6) II** Theoretical and practical applications of administration as a decision-making process in formulating a course of action essential to solving patient care and personnel issues in nursing. P, 600a or 600c, CR 600b.

- **624. Clinical Teaching in Collegiate Schools of Nursing (6) II** Curriculum planning and implementation; principles of teaching and learning, formulation of objectives, the selection and organization of learning experiences in the clinical area. Directed practice teaching is included in the area of clinical interest. P, 600a or 600c, CR 600b.

- **625a-625b. Physiological Concepts: Nursing (3-3)** S 625a: Stressor activated and host defense responses. Includes fever, nutrition, pain, sleep. Offered S 1986 625b: Health states such as hypoxia, perfusion, edema. Physiology of reproduction, menopause, infertility. Offered S 1985 625a is not prerequisite to 625b.
Methods in Nursing Research (3) I Critical examination of selected problems and methods in the nursing research process. P, 600a or CR.

Clinical Phenomena: Theories and Research (3) I Theory and research surrounding common clinical phenomena (e.g., pain, stress), with emphases on description of clinical phenomena and identification of strengths and weaknesses in available knowledge and research. Laboratory is required. P or CR, 630, 600a or 600b or 600c.

Nursing In a Clinical Subspecialty (4-12) 680a: Clinical physiology, pathophysiology, and nursing skills, as related to a selected subspecialty area; major subspecialty health problems and impact on the individual, the family and society. Laboratory is required. 680b: Integration and application of previous content, including exploration of expanded role at subspecialty level. Laboratory is required. P, master's degree or 600a, 600b, 600c, 602, 620, 624, 630, or 631. Both 680a and 680b are offered fall and spring semesters.

Dynamics of Behavior in Patients with Chronic Disease (3) I S Behavioral problems of individuals with chronic diseases and ways of intervening. Open to majors only.

Primary Care Nursing I (6) S Knowledge and skills in health assessment, health promotion, and anticipatory guidance throughout the lifespan; assessment and management of pediatric and adult common, acute, and chronic health problems. 2R, 12L. P, admission to N.S. Program.

Primary Care Nursing II (6) I Advanced training in health promotion and anticipatory guidance throughout the lifespan; assessment and management of common, acute, and chronic pediatric and adult health problems. 2R, 12L. P, 683 and admission to N.S. program.

Family Health Care Management (2) I Knowledge and skills in family assessment and health care management relevant to their practice as Primary Care Nursing Specialist students; emphasis on application of family theory. 1R, 3L. P. 683 and admission to N.S. program.

Testing Nursing Theory (3) I Examination of selected theories currently utilized in nursing; testing of theories in practice; provision for an exercise in theory construction. Laboratory is required. P. 600a-600b-600c, 602, 630, six units of adv. human physiology, six units of an adv. social science.

Clinical Nursing Research (3) II Investigation of selected strategies appropriate to researching problems in clinical nursing. P, 600a-600b-600c, 602, 705, 630.

Methods in Clinical Nursing Research (3) I Application of research methods from the physical and social sciences to clinical nursing; experimental and nonexperimental designs; collection, analysis and interpretation of data; computer use. P, 705, 710, 630.

Study of Social Influences (3) S 1986 In-depth examination of social forces affecting the health care system.

Instrument Construction (3) S 1987 Deductive process for construction/testing instruments to measure nursing care interventions/patient outcomes. Includes deductive instrument strategies; experience developing a pilot measure. 2R, 3L. Open to majors only. P, 705, 710, grad, level statistics.

Field Work In Nursing Research (3-3-3) S II Individualized course of study incorporating research and clinical knowledge in a selected area of nursing practice in the laboratory and field setting. P, 600a-600b-600c, 602, 630, 705, 710.

NUTRITION
(See Nutrition and Food Science, Nutritional Sciences)

NUTRITION AND FOOD SCIENCE

NUTRITION AND FOOD SCIENCE 251

Assistant Professors Patsy M. Brannon, Roger A. Sunde.

The Department of Nutrition and Food Science is concerned with advanced training in the areas of dietetics and food science and offers programs leading to the Master of Science degree with majors in these areas. Graduate study prepares students for careers in government and universities, in the food industry, and as dieticians. The department also cooperates with the Committee on Nutritional Sciences and with the Departments of Biochemistry and Microbiology and Immunology through courses and research direction for students working toward the Master of Science or Doctor of Philosophy degrees with majors in nutritional sciences, in biochemistry, or in microbiology. Cooperative arrangements are maintained with the Arizona Health Sciences Center and other health care and educational facilities to provide work applicable to particular degree programs.

Applicants for the food science major should have a fundamental background in the physical and biological sciences, including one year each of general biology, organic chemistry with lab, and physics, as well as one semester each of microbiology and college algebra. Admission to the dietetics program is contingent upon completion of a bachelor’s degree with a strong concentration in human nutrition and dietetics.

A thesis based on experimental work is required for the food science major, Master of Science degree. Students in the dietetics major may choose a thesis or nonthesis option*. The thesis option requires 30 units (a maximum of six units may be from the department’s A.D.A.-approved internship), including a thesis based on experimental work. The nonthesis option requires 40 units (a maximum of 12 units may be from the department’s A.D.A.-approved internship). Graduate units from other A.D.A.-approved internships may be used to the limit of transfer-unit requirements. In lieu of internship credit, units may be applied from the following functional areas: clinical nutrition, food service management, community nutrition, and consumer service in foods.

* This option is currently under review. For further information, contact the department graduate committee.


408. Human Nutrition (3) GC I Concepts of the physiology and biochemistry of nutrients and nutrient homeostasis in humans. P, 406a-406b or Bioc. 460, Ecol. 159a-159b, CR 464a. Lei

410. General Human Nutrition (3) GC II Advanced principles of nutrition: digestion, absorption and utilization of nutrients. Open to non-majors only. P, Chem. 112 or Micr. 103 or consult department before enrolling.

430. Principles of Nutrition (3) GC I II (Identical with An.S. 430 )

441. Therapeutic Nutrition (4) GC 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.

447. Perspectives in Geriatrics Laboratory (1) GC II (Identical with Ph.Pr. 447 )

448. Perspectives in Geriatrics (2) GC II (Identical with Ph.Pr. 448 )

455. Food Product Development (3) GC I II Flavor, color, texture, temperature and appearance, as related to acceptability of food products; analysis of change during storage, preservation and preparation, as related to food composition and quality. 1R, 6L. P, 251, 360. Tinsley

458. Food Service Organization and Management (3) GC I Organization and management of food service systems; responsibilities of management for leadership, sanitation, maintenance, and care of food service plant and its equipment. P, 258. Tinsley

459. Sensory Evaluation of Food (3) GC II 1985-86 Fundamentals of taste, odor, color, and rheology perception as related to food; design and methodology of small-panel and consumer-panel testing. 2R, 3L.

460. General Biochemistry (5) GC I (Identical with Bioc. 460 )
252 DEPARTMENTS AND COURSES OF INSTRUCTION


466. Postharvest Physiology (3) GC II 1985-86 (Identical with Pl.S. 466)

468. Food Processing (3) GC I Refrigeration, freezing, dehydration, heating, fermentation and pickling, irradiation and addition of chemicals, as they apply to food preservation and processing, retention of nutritive value, flavor, appearance and safety. P, Chem. 241b, Micr. 110. Price

470. Food Microbiology and Sanitation (3) GC II Microbiology in processing and handling of foods; relation of microorganisms, insects, and rodents to design and function of processing and handling equipment. P, Micr. 120 or 217. (Identical with Micr. 470) Gerba

471. Food Microbiology and Sanitation Laboratory (2) GC II 1986-87 Lab. procedures for assessment of sanitary quality of foods. P, 470 or CR. (Identical with Micr. 471) Gerba

480. Composition and Structure of Meat (2) GC II 1985-86 (Identical with An.S. 480)


538. Problems in the Biochemistry of Aging (2) I 1986-87 Current topics in the biochemistry of mammalian aging; examination of the metabolic, hormonal, immunologic and neural aspects of aging in lower mammals and humans. P, 406a-406b or Chem. 460 or 462b. McCaughey

549. Interdisciplinary Approaches to Health Care of the Aged (3) S (Identical with Ph.Pr. 549)

560. Advanced Food Chemistry (3) I 1985-86 Chemical and physical structure and functions of food constituents, additives, and food properties. P, 360, CR 406a. Berry

568a-568b. Nucleic Acids (3-3) 1985-86 (Identical with Bioc. 568a-568b)

596. Seminar cc. Community and International Nutrition (2) II (Identical with F.C.M. 596cc, which is home)


602. Metabolic Integration (2) II Food intake, transport, protein and amino acid utilization in higher animals. P, 408. Sunde

609. Nutritional Biochemistry Techniques (3) I 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) Reid

615. Chemistry and Metabolism of Lipids (3) I 1985-86 Chemistry and structure of lipids and their digestion, adsorption, transport and utilization; current research in lipid metabolism and the role in lipids in certain disease states. P, 406a-406b. Marchello

617. Steroid Chemistry and Biochemistry (3) I 1986-87 Occurrence, biosynthesis and function of steroids in animals, plants and microorganisms; chemical reactions and metabolism; chromatographic analysis. P, 406a-406b or Chem. 460 and 241a-241b. (Identical with Bioc. 617 and Chem. 617)


630. Developmental Nutrition (3) II Role of nutrients in development and growth; changes in maternal and child nutritional requirements due to development and growth; current research in developmental nutrition. P, 408. Brannon

640a-640b. Field Methods in Human Nutrition (3-3) Case-oriented approach to nutritional assessment, diagnosis, prescription, plan and prognosis; application of dietary, clinical and biochemical methods. 2R, 3L. Open to majors in N.F.S. and other health sciences areas only. Kight

645. Nutritional Pathology (2) I Identification of nutrient-based lesions; diagnosis of causative factors, using clinical, biochemical and dietary data. Sheehan

663. Chemistry of Food Carbohydrates (2) II 1986-87 Chemical and physical properties of carbohydrates important to their presence in food. P, Bioc. 462a, 460 or N.F.S. 406a-406b Berry
665. Chemistry of Food Proteins (3) II 1985-86 The chemical and physical properties of proteins important to their use as food; analysis and purification of proteins; biochemical properties of proteins in muscle, milk, eggs, cereals, and other foods. P, Bioc. 462a preferred, Bioc. 460 or N.F.S. 406a-406b acceptable. (Identical with Bioc. 665) Goll

672. Food Safety (2) I 1985-86 Significance and control of foodborne hazards associated with pathogenic microorganisms, microbial toxins, industrial chemicals, and other environmental contaminants. P, 471, Chem. 241b. (Identical with Micr. 672) Gerba

693. Internship
   a. Dietetic Internship, ADA Accredited (1 to 6) [ Rpt./2] II Field trips. Consult dept. before enrolling. Open to majors only. P, Course work equivalent to American Dietetic Association Plan IV.

696. Seminar
   b. Nutrition (1) I II (Identical with Nu.Sc. 696b)
   c. Food Science (1) III

NUTRITIONAL SCIENCES

Committee on Nutritional Sciences (Graduate)

Professors James W. Berry (Nutrition and Food Science), William H. Brown (Animal Sciences), Herbert E. Carter (Emeritus, Biochemistry), Milos Chvapil (Surgery), David L. Earnest (Internal Medicine), Darrel E. Goll (Nutrition and Food Science; Biochemistry), William H. Hale (Animal Sciences), Mark Haussler (Biochemistry), J. Tal Huber (Animal Sciences), Wayburn S. Jeter (Microbiology and Immunology), Mary Ann Kight (Nutrition and Food Science, Otakar Koldovsky (Pediatrics), John A. Marchello (Animal Sciences; Nutrition and Food Science), W. F. McCaughey (Nutrition and Food Science), Donald J. McNamara (Nutrition and Food Science); Bobby L. Reid (Animal Sciences; Nutrition and Food Science), Richard W. Rice (Animal Sciences), Frank D. Rollins (Animal Sciences; Nutrition and Food Science), William A. Stini (Anthropology), J. Warren Stull (Nutrition and Food Science), Brent Theurer (Animal Sciences), Hugo V. Villar (Surgery), Charles W. Weber (Nutrition and Food Science; Animal Sciences), Michael A. Wells (Biochemistry), Frank M. Whiting (Animal Sciences), Jack H. Wilmore (Exercise and Sport Sciences)

Associate Professors Gail G. Harrison (Family and Community Medicine; Pediatrics; Nutrition and Food Science) Chairperson, Ronald E. Allen (Animal Sciences; Nutrition and Food Science), James Blanchard (Pharmaceutical Sciences), Sergio Bustamante (Pediatrics), K. Y. Lei (Nutrition and Food Science), Frank L. Meyskens (Internal Medicine), Ralph L. Price (Nutrition and Food Science), Edward T. Sheehan (Nutrition and Food Science), Spencer Swingle (Animal Sciences)

Assistant Professors Patsy M. Brannon (Nutrition and Food Science), Murray Korc (Internal Medicine), W.A. Schurg (Animal Sciences), Roger A. Sunde (Nutrition and Food Science), Ann M. Tinsley (Nutrition and Food Science), Marc E. Tischler (Biochemistry)

The interdepartmental Committee on Nutritional Sciences offers graduate work leading to the Master of Science and the Doctor of Philosophy degrees with a major in nutritional sciences. Options in nutritional biochemistry, human nutrition (clinical or community), or animal nutrition may be selected within this major. The Committee 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 one year of college-level mathematics (calculus 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.

**Degrees**

**MASTER OF SCIENCE** — The student's course of study will be developed by the student and the thesis director and approved by the student's graduate advisory committee and the Committee on Nutritional Sciences. A thesis based on research and a final oral examination are required. All students are required to complete six semester units of biochemistry, three units of statistics, six units of nutrition courses, and two units of seminar, at least one of which must be 696. Students in nutritional biochemistry must complete an additional unit of biochemistry, and students in human nutrition must complete three units of physiology.

**DOCTOR OF PHILOSOPHY** — The student's course of study will be developed by the student and the dissertation director and approved by the student's graduate advisory committee and the Committee on Nutritional Sciences. Normally, students are admitted to the Ph.D. program only after completing the requirements for the master's degree. A student who has demonstrated exceptional research and academic proficiency may, on the recommendation of the major adviser and approval of the Committee on Nutritional Sciences, omit the master's degree and proceed directly to the qualifying examination for the Doctor of Philosophy. Students must meet the minimum requirements established for the master's degree in their options, plus any 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.

Programs for both degrees will emphasize courses from the following listing.

**Related Courses**


**696. Seminar**

b. Nutrition (1) I II (Identical with N.F.S. 696b, which is home)

**OCCUPATIONAL SAFETY AND HEALTH**

*(See Health-Related Professions)*

**OPERATIONS MANAGEMENT**

*(See Management and Policy)*
OPTICAL SCIENCES

Committee on Optical Sciences (Graduate)


Associate Professor Eustace L. Dereniak
Assistant Professors Ursula J. Gibson, William M. Hetherington III (Chemistry), Chris L. Koliopoulos, Nasser Peyghambarian (Research), Robin N. Strickland (Electrical and Computer Engineering)

The Committee on 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 thin-film technology. Interdisciplinary programs in progress involve the Departments of Astronomy, Chemistry, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Microbiology and Immunology, Physics, Physiology, Planetary Sciences, and Radiology, as well as the Microelectronics Laboratory, Arizona Research Laboratory and the Optical Circuitry Cooperative.

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 Assistant 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 advanced (engineering, mathematics, or physics) tests of the Graduate Record Examination, and at least two letters of recommendation. The deadline for receipt of all materials is one month prior to registration, but earlier receipt will enhance the prospects for admission and financial aid.

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).

434. Electrical, Magnetic and Optical Properties of Materials (3) GC I 1986-87 (Identical with M.S.E. 434)

440a-440b. Atomic and Molecular Spectroscopy for Experimentalists (3-3) GC (Identical with Phys. 440a-440b)

501. Electromagnetic Foundations of Optics (3) I Gauss’ law; Coulomb’s law; dipole moment; polarizability; Faraday’s law; Maxwell’s equations; the wave equations; plane waves; spherical waves; Fresnel’s formulas; dipole radiation; magneto-optic effects; electro-optic effects. P, Phys. 116, Math. 422b.

502. Introduction to Fourier Optics (3) I Harmonic analysis; linear systems; impulse response; convolution; Fourier transform; transfer function; diffraction; image formation; holography; optical data processing. P, Math. 223.

503. First-Order Optical Design (3) I Rays and wavefronts; Fermat’s principle; Snell’s law; dispersion; systems of plane mirrors; Gaussian imagery; paraxial imagery; paraxial design methods; Delano diagram; introduction to aberrations.

503L. First-Order Optical Design Laboratory (1) I Lab. in support of 503. P, CR 503.

504. Introduction to Quantum Optics (3) II Quantum background; interaction of radiation with matter; dipole moments; line broadening; quantization of radiation fields; spontaneous emission; stimulated emission; lasers. P, 501, Phys. 230. (Identical with Phys. 504)

505. Interference and Interferometry (3) II Wave equations; energy flow; polarization; interference; coherence; interferometers; optical testing; heterodyne interferometry; holography; speckle interferometry. P, 501, 502.

505L. Interference and Interferometry Laboratory (1) II Lab. in support of 505. P, CR 505.

506. Principles of Optical Systems Design (3) II Sources of aberrations; aberration control; aberrations in simple systems; vision; color; mechanical design principles. P, 503, 503L.

507. Introduction to Solid-State Optics (3) I Solid-state background; lattice vibrations; energy bands; energy gaps; optical properties of metals, insulators and semiconductors; measurement techniques; modulators; light-emitting diodes. P, 504.

508. Probability and Statistics in Optics (3) II Probability; random variables; stochastic processes; autocorrelation; Wiener spectrum; noise; applications in photography; atmospheric turbulence; analysis of random data. P, 502.

509. Radiometry, Sources, Materials and Detectors (3) II Radiometry; sources; materials and components for optical systems; imaging and non-imaging detectors. P, 502, 503, 503L.

513. Optical Testing (3) I 1985-86 Metrology of components; aspheric surface testing; assembly and alignment of systems; system evaluation. P, 505.


514. Aberration Theory (3) II 1986-87 Aberration theory; geometrical image formation; diffraction; pupil, spread, and transfer functions; random wavefront perturbations; system effects; image evaluation; image processing. P, 503.

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 1985-86 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 1986-87 Historical background; the Gabor hologram; the hologram as a zone plate; Fresnel, image, Fourier-transform, and reflection holograms; practical holography; limitations. P, 505.

531. Image Processing Laboratory (3) I (Identical with E.C.E. 531)

533. Image Processing: Devices, Systems and Applications (3) II 1985-86 Image formation; resolution; noise; linear processing; display; discrete images; sampling; coding; maximum efficiency codes; nonlinear computer processing; coherent processing. P, 502 or background in theory of linear systems. (Identical with E.C.E. 533)


541. Introduction to Lasers (3) I Laser theory; properties of lasers; stimulated emission; dispersion theory; gain saturation and rate equation; optical resonators; surveys of laser types and mechanisms. P, Phys. 103b.

541L. Introduction to Lasers Laboratory (1) I Lab. in support of 541. P, CR 541.

543. Laser Physics (3) I 1986-87 Density matrix formulation of interaction of radiation with matter; semiclassical laser theory; single and multimode scalar fields; moving atoms; ring and Zeeman lasers; pressure effects. P, 504. (Identical with Phys. 543)

544. Advanced Electrodynamics (3) I 1985-86 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 1985-86 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.

552. Optical Properties of the Atmosphere and Ocean (3) I 1986-87 Fluctuations in modulus, phase, and coherence caused by turbulence and scattering; polarization; absorption; dispersion; visibility; transfer function; resolution; experimental data. P, CR 508.

558. Radiometry (3) I 1985-86 Units and nomenclature; Planck’s law; black bodies; gray bodies; spectral emitters; Kirchhoff’s law; flux concepts; axial and off-axis irradiance; radiative transfer; normalization; coherent illumination; radiometric Instruments. P, 501.

559. Infrared Techniques (3) I 1986-87 The radiant environment; atmospheric properties; optical materials and systems; detector description and use; data processing; displays, systems design and analysis. P, 558.

563. Photovoltaic Imaging Devices (3) II 1985-86 Intensifiers; camera tubes; electronography; storage tubes; specifications; evaluation; applications. P, Phys. 116.

565. Radiation Detector Laboratory (2) I 1985-86 Operational amplifiers, noise, signal processing, photovoltaic and photoconductive detectors, photomultipliers, thermal detectors. 6L. P, 509, CR 566.

566. Optical Detectors (3) II 1986-87 Photoconductors; 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 1986-87 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.
258 NEW DEPARTMENTS AND COURSES OF INSTRUCTION

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 1986-87 Dielectric interference films; semiconductor and metallic films; planar wave guide films; design methods for multilayer interference filter coatings; thin film components for integrated optical circuits. P, 505.

595. Colloquium a. Current Subjects in Optical Sciences (1) I II

596. Seminar a. Introduction to Thin-Film Techniques (2) I 1985-86 P, Phys. 330


643. Quantum Optics (3) II 1986-87 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. 643)

656a-656b. Atmospheric Optics and Radiation (3-3) 1986-87 (Identical with Atmo. 656a-656b)

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. P, C.Sc. 122 or E.C.E. 171.


ORIENTAL STUDIES


Associate Professors Michael E. Bonine, Constance Cronin (Anthropology), Richard M. Eaton, Leslie A. Flemming, Charles H. Hedtke, Chisato Kitagawa, Peter Machinist, Ronald B. Miao, Michael Schaller (History), Daniel Swetschinski, William J. Wilson, Norman Yoffee (Anthropology)

Assistant Professors Marie Chan, John Y. Hou,

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Oriental studies. Instruction is available in the languages, cultures, and civilizations of the Middle East and North Africa, India and Pakistan, China, Japan, the Judaic world, 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 Oriental 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 advisers. Students without previous disciplinary or language training related to Asia may be required to make up deficiencies without graduate credit.
Degrees

MASTER OF ARTS — Requirements include thirty 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 adviser: (1) a nonspecialist terminal program, multi-area if desired, and (2) a specialist program requiring a minimum of two years of an appropriate language. This 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.

General Oriental Studies

421a-421b. East Asian Buddhism (3-3) GC 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. P, 330a or consult department before enrolling. (Identical with Reli. 421a-421b)


432. Islamic Mysticism (3) GC II 1986-87 Origin and development of Sufism and its impact on the Muslim and non-Muslim worlds. (Identical with Reli. 432)

451. The United States and East Asia: 1840 to the Present (3) GC II 1986-87 (Identical with Hist. 451a-451b)

463. Marxism in East Asia (3) GC I Evolution of Marxist thought in China and Japan. (Identical with Hist. 463)

464. International Relations of East Asia (3) GC II (Identical with Pol. 464)

468. Asia and the West (3) GC I Processes of interaction between Europeans and the peoples and cultures of the Middle East, South Asia, and East Asia, from the Portuguese explorations to the present. (Identical with Hist. 468)

489. Women in East Asia (3) GC I Women in traditional China and Japan; analysis of changes occurring in the modern period. (Identical with Hist. 489 and W.S. 489)

Proseminar

a. Special Topics in Asian Studies (3) [ Rpt./4] GC

596. Seminar
c. East Asian Societies (3) [ Rpt.] I II

China

400a-400b. Intermediate Modern Chinese (5-5) GC Grammar, reading, and conversation in the modern (Mandarin) language. P, 100b.


418. Classical Confucianism (3) GC I Formative, classical period in the history of the Confucian tradition, up to 200 A.D.; emphasis on the thought of Confucius, Mencius, and Hsun Tsu. P, 330a or consult department before enrolling. (Identical with Reli. 418)

419. Neo-Confucianism (3) GC II Major figures and themes in the Revival Confucianism from the 11th century through recent times; emphasis on the thought of Chu Hsi and Wang Yang-ming. P, 330b or consult department before enrolling. (Identical with Reli. 419)

420a-420b. Linguistic Structure of Modern Chinese (3-3) GC Linguistic study of the phonological, morphological, and syntactic systems of modern Chinese, with particular attention to linguistic analysis. (Identical with Ling. 420a-420b)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>440.</td>
<td>Chinese Calligraphy (2) GC [ Rpt. ] I 1985-86 Theory, practice, and aesthetics of Chinese brush writing, with emphasis on individual training and development.</td>
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<td>443.</td>
<td>Chinese Aesthetics (2) GC II Survey of traditional Chinese aesthetic concepts in language, literature, painting, calligraphy, and design.</td>
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<td>460.</td>
<td>Modern Chinese Foreign Relations (3) GC II (Identical with Pol. 460)</td>
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<tr>
<td>461a-461b.</td>
<td>Chinese Politics, 1911-Present (3-3) GC (Identical with Pol. 461a-461b)</td>
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<tr>
<td>475a-475b-475c-475d-475e.</td>
<td>Periods in Chinese History (3-3-3-3-3) GC In-depth treatment of major premodern eras. 475a: Ancient and classical, to 200 B.C. 475b: Early Empire, 200 B.C.-200 A.D. 475c: Medieval, 200-750 A.D. 475d: New Empire, 750-1350 A.D. 475e: Late Empire, 1350-1800 A.D. May be taken in any order and CR. (Identical with Hist. 475a-475b-475c-475d-475e)</td>
<td>4-4</td>
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<tr>
<td>476.</td>
<td>Modern Chinese History (3) GC Historical survey of the period since 1911 which examines the revolutionary developments shaping contemporary China. (Identical with Hist. 476)</td>
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<tr>
<td>482.</td>
<td>Social History of China (3) GC 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. 482)</td>
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<td>495.</td>
<td>Colloquium</td>
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<tr>
<td>495a-495d.</td>
<td>Revolution in Chinese History (3) GC II (Identical with Hist. 495a)</td>
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<td>495e.</td>
<td>Modern Chinese Frontier Areas (3) GC I 1985-86 (Identical with Hist. 495d)</td>
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<td>496.</td>
<td>Seminar</td>
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<tr>
<td>496a-496g.</td>
<td>The Archaeology of Pre-Han China (3) GC II (Identical with Anth. 496g, which is home)</td>
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<tr>
<td>500a-500b.</td>
<td>Literary Chinese (3-3) Introduction to pre-20th-century Chinese styles through readings in classical Chinese literature.</td>
<td>3-3</td>
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<tr>
<td>510a-510b.</td>
<td>Chinese Historical Linguistics (3-3) II 1986-87 Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax.</td>
<td>3-3</td>
<td>P, 400b and a course in general ling.</td>
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<tr>
<td>520.</td>
<td>Resources and Methods in Sinology (3) II 1985-86 Introduction to and exercises in the use of standard Sinological reference and research resources.</td>
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<td>P, 500b.</td>
</tr>
<tr>
<td>550.</td>
<td>Studies in Modern Chinese (3) [ Rpt./1] S Grammar, conversation, and readings in modern Chinese texts, with emphasis on oral and written comprehension and expression.</td>
<td>3</td>
<td>P, 400b.</td>
</tr>
<tr>
<td>553.</td>
<td>Readings in Classical Chinese Prose (3) [ Rpt./2] I 1985-86 Readings in selected texts from literary, philosophical, and historical traditions; includes selections from the Five Classics and the great prose masters of the Han-Quing. Variable content.</td>
<td>3</td>
<td>P, 500b.</td>
</tr>
<tr>
<td>554.</td>
<td>Readings in Modern Chinese Literature (3) [ Rpt./2] I I I Readings in Chinese literature since 1900. Variable content drawn from short stories, novels, drama, and poetry.</td>
<td>3</td>
<td>P, 400b.</td>
</tr>
<tr>
<td>555.</td>
<td>Readings in Chinese Classical Vernacular Texts (3) [ Rpt./2] I 1986-87 Readings in narrative and dramatic texts from the 12th to the 18th century, written in early vernacular. Includes zaju, bianwen, chuangzi, and xiaoshuo traditions. Variable content.</td>
<td>3</td>
<td>P, 500b.</td>
</tr>
<tr>
<td>570.</td>
<td>Chinese Historical Texts (3) [ Rpt./2] II 1986-87 Readings in traditional historical texts of various types.</td>
<td>3</td>
<td>P, 500b.</td>
</tr>
<tr>
<td>595.</td>
<td>Colloquium</td>
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<tr>
<td>595a-595d.</td>
<td>China (3) [ Rpt.] I I I</td>
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<tr>
<td>596.</td>
<td>Seminar</td>
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<tr>
<td>597.</td>
<td>Modern Chinese Literature (3) [ Rpt.] I I I</td>
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<tr>
<td>598.</td>
<td>Premodern Chinese History and Politics (3) [ Rpt.] I I I</td>
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<tr>
<td>599.</td>
<td>Modern Chinese History and Politics (3) [ Rpt.] I I I</td>
<td></td>
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<tr>
<td>599a-599b.</td>
<td>Intermediate Hindi-Urdu (4-4) GC Advanced grammar, reading, and conversation in the major national language of northern India and Pakistan, with separate sections for written Urdu and written Hindi.</td>
<td>4-4</td>
<td>P, 101b.</td>
</tr>
</tbody>
</table>

India-Pakistan

408a-408b. Intermediate Hindi-Urdu (4-4) GC Advanced grammar, reading, and conversation in the major national language of northern India and Pakistan, with separate sections for written Urdu and written Hindi. P, 101b.
417a-417b. Sanskrit Grammar and Texts (3-3) GC 1986-87 Study of the classical language of India, with emphasis on reading and translation, including selections from the Gita, Vedas, Mahabharata, Hitopadesha, Kathasaritsagara, and Laws of Manu. (Identical with Clas. 417a-417b and Ling. 417a-417b)

431. Indian Religion and Thought (3) GC II 1985-86 Traditional religious and philosophical thought of India. (Identical with Reli. 431)

444a-444b. Literature of India (3-3) GC 444a: Ancient and classical literature; philosophical, epic, dramatic, and poetic literature until 1200 A.D. 444b: Modern literature; lyric poetry, short stories and novels by contemporary writers. In Engl. 444a is not prerequisite to 444b.

445. Hindu Mysticism (3) GC II 1986-87 Introduction to the major concepts and practices of Hindu mysticism, including yoga techniques, rites, symbols, and myths. (Identical with Reli. 445)

471. Introduction to Indic Civilization (3) GC I Social and political institutions, arts and philosophy of traditional society from prehistoric times to c. 1000 A.D., with emphasis on Hindu religion and its interrelations with the social order. (Identical with Anth. 471 and Hist. 471)

472. History of Medieval India (3) GC I 1985-86 Survey of Indian history from the 7th century to 1750. (Identical with Hist. 472)

473. History of Modern India and Pakistan: 1750-Present (3) GC II 1985-86 Survey of political, social and economic developments in South Asia from the mid-18th century to the present. (Identical with Hist. 473)

485. Social Organization of India and Pakistan (3) GC I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with Anth. 485)

501. Advanced Hindi-Urdu (3) [Rpt.] Advanced conversation, writing and reading of modern prose, with separate sections for written Hindi and written Urdu.

502. Literary Japanese (3) Introduction to the varieties of writing styles used from the 8th century to modern times, including Sino-Japanese, documentary, epistolary and purely literary styles.
595. Colloquium
   b. Japan (3) [ Rpt.] II

596. Seminar
   r. Japanese History (3) [ Rpt.] II
   s. Japanese Literature (3) [ Rpt.] II

Judaic Studies

401. Ancient Mesopotamia (3) GC I 1986-87 (Identical with Anth. 401)

403a-403b. Intermediate Modern Hebrew (5-5) GC Intermediate grammar, reading, conversation, and extensive presentation of the syntax and vocabulary of modern Hebrew, leading to a firm foundation in the language. P, 103b.


427. Religion and Mythology of Mesopotamia (3) GC II 1986-87 (Identical with Anth. 427)

428. Anthropology of Law (3) GC II 1986-87 (Identical with Anth. 428)

430. Prophecy In Ancient Israel (3) GC II Nature and origins of Biblical prophecy and its ancient Near-Eastern analogues, including intensive study of several major Biblical prophets. (Identical with Reli. 430)


436. Modern Jewish Political Thought (3) GC I 1985-86 Analysis of the various forms of modern Jewish nationalism (e.g., Zionism, Bundism, Diaspora nationalism), their intellectual roots and socioeconomic settings.

453. Advanced Hebrew (3) GC [ Rpt.] Advanced topics in Biblical, Rabbinic, and/or modern Hebrew language and literature. P, 403b or 409b.

455. Introduction to Rabbinic Literature (3) GC II Reading in translation and interpretation of Hebraic, Jewish, Rabbinic, and related literatures including legal, ethical, moral, and social interpretation of Scripture and oral traditions. (Identical with Reli. 455)

595. Colloquium
   g. Judaic Studies (3) [ Rpt./4] GC Consult department before enrolling.

Middle East


405a-405b. Intermediate Persian (4-4) GC Conversation in the dialect of contemporary Iran; extensive readings in classical and modern literature. P, 105b.

414a-414b. Advanced Arabic (3-3) GC Continuation of 404b, with emphasis on oral and written comprehension and expression. P, 404b. 414a is not prerequisite to 414b.

415a-415b. Advanced Persian (4-4) GC Readings in Persian, with the objective of preparing the student for independent research. 415a: Contemporary prose. 415b: Poetry and prose. P, two yrs. of Persian. 415a is not prerequisite to 415b.

424a-424b. Conversational Levantine Arabic (3-3) GC 1985-86 Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and comprehension. P, 104a.

425a-425b. Conversational Gulf Arabic (3-3) GC 1986-87 Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and comprehension. P, 104a.

426. Introduction to Arabic Linguistics (3) GC II History and structure of the Arabic language in its various forms. P, 104b, Ling. 101. (Identical with Ling. 426)

434. Islamic Thought (3) GC II Traditional ideological systems of Islamic countries and their evolutionary transformations. (Identical with Reli. 434)
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>442</td>
<td>Transformation of Agrarian Societies in the Middle East</td>
<td>3</td>
<td>GC 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 A.Ec. 442, Pol. 442, Soc. 442)</td>
</tr>
<tr>
<td>448</td>
<td>Arabic Literature in English</td>
<td>3</td>
<td>GC II 1985-86 Historical survey of Arabic literature of the Middle East and Mediterranean world, with readings in English translations.</td>
</tr>
<tr>
<td>449</td>
<td>Persian Literature in English</td>
<td>3</td>
<td>GC II 1986-87 Historical survey of Persian literary traditions, with readings in English translations.</td>
</tr>
<tr>
<td>457</td>
<td>Prehistoric Mesopotamia</td>
<td>3</td>
<td>GC I 1985-86 (Identical with Anth. 457)</td>
</tr>
<tr>
<td>458</td>
<td>Government and Politics of the Middle East</td>
<td>3</td>
<td>GC II Government and politics of the Middle East, combining study of Islamic institutions with a view to their applicability in the contemporary Middle East. (Identical with Pol. 458)</td>
</tr>
<tr>
<td>459</td>
<td>Topics in Economic Geography of the Middle East</td>
<td>3</td>
<td>GC II (Identical with Geog. 459)</td>
</tr>
<tr>
<td>477a</td>
<td>History of the Middle East</td>
<td>3</td>
<td>GC History of civilization in the Middle East from the rise of Islam to the 18th century. 477a: Period of Arab dominance. 477b: Period of Turkish dominance. 477a is not prerequisite to 477b. (Identical with Hist. 477a-477b)</td>
</tr>
<tr>
<td>478</td>
<td>Modern History of the Middle East</td>
<td>3</td>
<td>GC I Near and Middle Eastern history since the late 18th century, with special emphasis on Egypt and areas to the east. (Identical with Hist. 478)</td>
</tr>
<tr>
<td>479</td>
<td>The Ottoman Empire to 1800</td>
<td>3</td>
<td>GC II 1986-87 Great age of the Ottoman state, its origins and decline. (Identical with Hist. 479)</td>
</tr>
<tr>
<td>480a</td>
<td>History of Iran and Central Asia</td>
<td>3</td>
<td>GC 480a: History of Iran from 226 A.D. to 1722. 480b: 18th, 19th and 20th century Iran. (Identical with Hist. 480a-480b)</td>
</tr>
<tr>
<td>481a</td>
<td>Archaeology of Syria-Palestine in the Bronze and Iron Ages</td>
<td>3</td>
<td>GC 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. (Identical with Anth. 481a-481b)</td>
</tr>
<tr>
<td>484a</td>
<td>Akkadian Linguistics</td>
<td>3</td>
<td>GC 1985-86 (Identical with Anth. 484a-484b)</td>
</tr>
<tr>
<td>495</td>
<td>Colloquium</td>
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<td>h.</td>
<td>Middle East</td>
<td></td>
<td>Consult department before enrolling.</td>
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<tr>
<td>n.</td>
<td>Modern Arabic Prose</td>
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<td>GC P, Two years of Arabic.</td>
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<tr>
<td>o.</td>
<td>Classical Arabic Prose</td>
<td></td>
<td>GC P, two years of Arabic.</td>
</tr>
<tr>
<td>584a</td>
<td>Readings in Akkadian</td>
<td>3</td>
<td>GC 1985-86 (Identical with Anth. 584a-584b)</td>
</tr>
<tr>
<td>595</td>
<td>Colloquium</td>
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<td>d.</td>
<td>Middle East</td>
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<td>Middle East: Topics in History and Civilization</td>
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**PALEONTOLOGY**

(See Geosciences)

**PERFORMANCE**

(See Music)

**PERSIAN**

(See Oriental Studies)
PHARMACEUTICAL SCIENCES

Professors Arnold R. Martin, Acting Head, Willis R. Brewer (Emeritus), Jack R. Cole, Michael B. Mayersohn, William A. Remers, Samuel H. Yalkowsky, Joseph A. Zapotocky (Emeritus)
Associate Professors James Blanchard, Joseph J. Hoffman (Arid Lands Resource Sciences), Karl H. Schram
Assistant Professor Michael D. Karol

The Department of Pharmaceutical Sciences includes the academic disciplines of pharmaceutical chemistry, pharmaceutics, and pharmacognosy. It offers programs leading to the Master of Science degree with a major in pharmacy. Concentrations within this major include pharmaceutical chemistry, pharmaceutics, and pharmacognosy. The department also offers programs leading to the Doctor of Philosophy degree with majors in pharmaceutical chemistry and in pharmacy, with a concentration in pharmaceutics.

A bachelor’s degree in pharmacy, chemistry, or biological science is prerequisite to admission to the graduate program. Admission to the doctoral programs usually requires, in addition, appropriate preparation in mathematics.

Teaching is part of the graduate learning process, and one or more years of teaching is generally required of graduate students. A thesis based upon laboratory research is required for the master’s degree. 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.

Specialized facilities of the College of Pharmacy available for graduate studies include a clinical pharmacokinetics laboratory, a mass spectrometry laboratory, large-scale natural product extraction equipment, animal facilities, and well-equipped laboratories for chemical synthesis, structure elucidation, and pharmaceutics research.


424. Antibiotics (2) GC I Principles of antibiotic chemotherapy and the properties of the antibiotics employed in therapeutics. P, 437b, Micr. 110, Pcol. 471 b (Identical with Ph.Pr. 424)

427. Antineoplastic Drugs (2) GC 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.

430a-430b. Medical Radiopharmaceuticals (3-3) GC Medical applications, safe handling, measurement and preparation of radiopharmaceuticals. 2R, 3L. P, Math. 123, 263, Phys. 102b, 180b, Chem. 103b, 104b.

437a-437b. Medicinal Chemistry and Pharmacognosy (4-4) GC 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 biologicals. P, 302b, Chem. 241b, 243b.

438. Pharmaceutical Analysis (2) GC II Modern methods and instrumentation used for qualitative and quantitative determination of drugs and metabolites. P, Chem. 323.

439. Pharmaceutical Analysis Laboratory (1) GC I Instrumental methods for identification and quantitation of drugs and their metabolites from biological samples using GC, HPLC and other modern instruments. 3L. P, 438 or CR.

475a-475b-475c. Pharmacotherapeutics (2-3-6) GC (Identical with Ph.Pr. 475a-475b-475c)

575. Advanced Pharmacotherapeutics (6) II (Identical with Ph.Pr. 575)
596. Seminar
a. Pharmaceutical Sciences (1) [ Rpt./5] II
b. Pharmaceutical Chemistry Research (1) [ Rpt./5] II
c. Pharmaceutics Research (1 to 2) [ Rpt./5] II Open to majors only.

601. Advanced Physical Pharmacy (3) II 1986-87 Applications of physical chemistry to pharmacy. P, physical pharmacy or physical chemistry course.

602. Physical-Chemical Properties influencing Drug Action (4) II 1986-87 Study of physical-chemical properties that influence the design of drug molecules, the formulation of these molecules into suitable delivery systems, and their release into the biological system. P, 302b.


630a-630b. Advanced Organic Medicinals (3-3) 1985-86 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.


634. Biomedical Applications of Mass Spectrometry (3) I 1986-87 Principles of mass spectrometry including instrumental design, interpretation of spectra, and applications to biomedical and related problems. P, Chem. 241b

875. Advanced Pharmacotherapeutics (Pharmacy) (6) (Identical with Ph.Pr. 875)

PHARMACOLOGY

(Department, College of Medicine)

Professors Thomas F. Burks, Head, David S. Alberts (Internal Medicine), H. Vasken Aposhian (Molecular and Cellular Biology), Klaus Brendel, Rubin Bressler (Internal Medicine), Burnell R. Brown (Anesthesiology), Ryan J. Huxtable, David G. Johnson (Internal Medicine), Eugene Morkin (Internal Medicine), Diane H. Russell, I. Glenn Sipes (Pharmacology and Toxicology), Henry I. Yamamura

Associate Professors Dean E. Carter (Pharmacology and Toxicology), Kenneth A. Conrad (Internal Medicine), Andre Dray, David L. Kreulen, Thomas J. Lindell, John D. Palmer, William R. Roeske (Internal Medicine), Stuart R. Snider (Neurology)

Assistant Professors Thomas P. Davis, Timothy C. Fagan (Internal Medicine)

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. 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. 601, Bioc. 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, 462a-462b or 501; Bioc. 501, Tox. 602a. (Identical with Tox. 550)


561a-561b. Introduction to Pharmacological and Toxicological Literature (1-1) Designed to broaden the background of students in pharmacology and toxicology, and to improve scientific communication skills. P, 501. (Identical with Pcol. 561a-561b)

576. Environmental Toxicology (3) I (Identical with Tox. 576)

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 pharmacological and toxicological techniques. P, CR 501, Bioc. 565, Psio. 601.

601. Analytical Instrumentation and Techniques (4) I (Identical with Tox. 601)

602a-602b. Biotoxicology (3-1) (Identical with Tox. 602a-602b)

653. Neuropharmacology (2) II 1986-87 (Identical with Pcol. 653)

654. Psychopharmacology (3) 1985-86 (Identical with Pcol. 654)

695. Colloquium a. Cellular/Molecular Pharmacology (1 to 3) [Rpt./3] I II P, 561b. (Identical with Pcol. 596a)

696. Seminar a. Advanced Graduate Research (1 to 3) [Rpt./3] I II P, 561b. (Identical with Pcol. 596a)

697. Analytical Instrumentation and Techniques (4) I (Identical with Tox. 601)

700. Research (1 to 6) Yr.

701. The Pharmacological Basis of Therapeutics (6) II

PHARMACOLOGY AND TOXICOLOGY

(Department, College of Pharmacy)

Professors I. Glenn Sipes, Head, Lincoln Chin, J. Wesley Clayton, Paul F. Consroe, Albert L. Picchioni, Findlay E. Russell

Associate Professors G. Timothy Bowden, Dean E. Carter, A. Jay Gandolfi, Hugh E. Laird, II, David L. Nelson

Assistant Professor James R. Halpert

Pharmacology is the science concerned with all aspects of the action of drugs on living systems. Its primary aim is the development and evaluation of drugs for the treatment of human disease. The broad scope of interests of pharmacology ranges from the study of intermolecular reactions of chemical constituents of cells with drugs to the effects of chemicals in our environment on entire populations.

Toxicology is the science concerned with the harmful effects of chemicals (including drugs) on living systems. The toxicology program manages the University of Arizona Toxicology Laboratories. The program prepares students for careers in hospital laboratories, police crime laboratories, medical examiners’ offices, industrial hygiene laboratories, and toxicology laboratories in industry, government, and universities.
PHARMACOLOGY AND TOXICOLOGY 267

Pharmacology

The Department of Pharmacology and Toxicology in the College of Pharmacy cooperates with the Department of Pharmacology in the College of Medicine, 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 under Committee on Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements.

471a-471b. Fundamentals of Pharmacology (4-4) GC Comprehensive study of the biochemical, physiological, and therapeutic effects of drugs, including mechanisms of drug action and drug toxicity, and drug literature evaluation. 4R, 3L. P, Anat. 401, Bioc. 460 Psio. 480, 481; CR Ph.Pr. 475a-475b and Ph.Sc. 437a-437b (Identical with Tox. 471a-471b)

472. Applied Pharmacology (3) GC 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, Ecol. 159b.

474. Clinical Toxicology (2) GC II Prevention, characteristics, diagnosis and rational management of diseases caused by drug overdose, toxic household products, poisonous plants, venomous animals, environmental and industrial toxins. P, 472 or 471b, Ph.Pr. 475, Ph.Sc. 407. (Identical with Tox. 474)

475a-475b. Pharmacotherapeutics (2-3-6) GC (Identical with Ph.Pr. 475a-475b-475c)

561a-561b. Introduction to Pharmacological and Toxicological Literature (1-1) (Identical with Phcl. 561a-561b)

575. Advanced Pharmacotherapeutics (6) II (Identical with Ph.Pr. 575)

596. Seminar
   a. Advanced Graduate Research (1 to 3) [ Rpt./3] I II (Identical with Phcl. 596a, which is home)

653. Neuropharmacology (2) II Role of various neurochemicals in the autonomic and central nervous systems and the effect of drugs on the nervous system, including their influence on synthesis, storage, and release of neurochemicals. P, Phcl. 501 or Pcol. 471b, 561a, 596. (Identical with Phcl. 653 and Tox. 653)


695. Colloquium
   a. Research Conference (1 to 4) [ Rpt.] I II

875. Advanced Pharmacotherapeutics (Pharmacy) (6) (Identical with Ph.Pr. 875)

Toxicology

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. Two letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Required courses for the graduate program are 462a-462b (or Bioc. 464a-464b or Phys. 601), 471a-471b (or Phcl. 501), 474, 596a, 596b, 601, and 602. A thesis is required.

423R. General Pathology (3) GC II (Identical with V.Sc. 423R)

423L. General Pathology Laboratory (1) GC II (Identical with V.Sc. 423L)

DEPARTMENTS AND COURSES OF INSTRUCTION

462a-462b. Biochemistry (4-3) GC (Identical with Bio. 462a-462b)
464aR-464bR. Human Physiology (3-3) GC (Identical with Ecol. 464aR-464bR)
464aL-464bL. Human Physiology Laboratory (1-1) GC (Identical with Ecol. 464aL-464bL)
465. Statistics for the Medical Sciences (4) GC I (Identical with Stat. 465)
471a-471b. Fundamentals of Pharmacology (4-4) GC (Identical with Pcol. 471a-471b)

474. Clinical Toxicology (2) GC II (Identical with Pcol. 474)
480. Human Physiology (4) GC I (Identical with Psio. 480)
481. Physiology Laboratory (1) GC I (Identical with Psio. 481)
486. Fundamentals of Industrial Hygiene (3) GC I (Identical with O.S.H. 486)
487. Advanced Industrial Hygiene and Safety (3) GC II (Identical with O.S.H. 487)
501. The Pharmacological Basis of Therapeutics (6) II (Identical with Phcl. 501)
508. Insect Toxicology (3) II 1985-86 (Identical with Ento. 508)
550. Drug Disposition and Metabolism (2) II (Identical with Phcl. 550)
551. Molecular Biology of Pharmacological Agents (3) I 1985-86 (Identical with Phcl. 551)
554. Industrial Toxicology and Chemical Exposures (4) I Principles of toxicology related to industry; dose response; mechanisms of toxicity; hazard evaluation principles; toxicology of major classes of industrial compounds. P, six units each of bio. sci. and organic chem.
576. Environmental Toxicology (3) I 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 bio and of organic chem.; Chem. 325, 326. (Identical with Ento. 576 and Phcl. 576)
596. Seminar
   a. Advanced Toxicology (1 to 2) [ Rpt./3] I
   b. Current Concepts in Toxicology (1 to 2) [ Rpt./3] II

601. Analytical Instrumentation and Techniques (4) I Lecture and lab. 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. 2R, 6L. P. Chem. 400a. (Identical with Phcl. 601)

602a-602b. Biotoxicology (3-1) 602a: Lecture. Mechanisms of organ directed toxicities in animals. Chemical carcinogenesis, teratogenesis and mutagenesis. Open to non-majors. P, two semesters of ecol. 602b: Laboratory. Proper use of animals in toxicology and pharmacology research and focuses on organ specific toxicities. (Identical with Phcl. 602)

610. Topics in Advanced Toxicology (1 to 3) I II Current developments in toxicology including: chemical carcinogenesis, mutagenesis and teratogenesis; behavioral toxicology; inhalation toxicology; toxicokinetics; metabolism and environmental toxicology. P. 471b, 474.

653. Neuropharmacology (2) II (Identical with Pcol. 653)

PHARMACOLOGY AND TOXICOLOGY

Committee on Pharmacology and Toxicology (Graduate)

Professors I. Glenn Sipes, Chairperson, Klaus Brendel, Thomas F. Burks, Diane H. Russell
Associate Professors Dean E. Carter, David L. Kreulen, Hugh E. Laird, II, David L. Nelson

The Department of Pharmacology in the College of Medicine and the Department of Pharmacology and Toxicology in the College of Pharmacy cooperate, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science with a major in pharmacology and the Doctor of Philosophy with a major in pharmacology and toxicology. Concentrations are available in neuropsychopharmacology; in biochemical, molecular, behavioral, cardiovascular, endocrine, gastrointestinal, and autonomic pharmacology; and in biochemical, occupational, inhalation, and environmental toxicology.
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 Committee on Pharmacology and Toxicology.

Graduate study programs are individually planned after consideration of the student’s preparation and professional objectives. A thesis is required.

For course descriptions, see Pharmacology (College of Medicine) and Pharmacology and Toxicology (College of Pharmacy) elsewhere in this catalog.

PHARMACY PRACTICE

Professor Theodore G. Tong
Associate Professors J. Lyle Bootman, Head, Alan D. Barreuther, William F. McGhan, Gary H. Smith

The Department of Pharmacy Practice offers a program leading to the Master of Science degree with a major in pharmacy with concentrations in hospital pharmacy and pharmacy administration. Graduate study in pharmacy administration 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 hospital pharmacy concentration. Admission preference for graduate study in pharmacy administration is given to applicants who hold the degree of Bachelor of Science in Pharmacy or its equivalent. 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 anthropology, biostatistics, computer science, economics, educational psychology, management, marketing, management information systems, psychology, public administration, or sociology.

419. Parenteral Preparations (2) GC Principles and procedures in the preparation, stability, and administration of parenteral products. 1R, 3L. P, Ph.Sc. 302b or CR.
424. Antibiotics (2) GC I (Identical with Ph.Sc. 424 )
440. Perspectives in Health Care Services (3) GC I Consumers, providers, financers, and regulators of health care in the U.S. and exploration of medication usage in relation to these components. (Identical with Rhab. 440 )
445. Nonpharmacological Issues of Medicines (3) GC I An overview of the drug-use process, including an examination of social, behavioral, and economic factors associated with the prescribing, dispensing, and use of drugs. (Identical with Coun. 445 )
447. Perspectives in Geriatrics Laboratory (1) GC II Open to nonmajors. P, CR 448. (Identical with Gero. 447 and N.F.S. 447 )
448. Perspectives in Geriatrics (2) GC II Multidisciplinary approach to the health-care needs of the elderly, including medication use and nutrition, through didactic training, a team project, and clerkship experiences. Open to nonmajors. P, CR 447 for nonmajors. (Identical with Gero. 448 and N.F.S. 448 )
475a-475b-475c. Pharmacotherapeutics (2-3-6) GC Common diseases that afflict humans. Their management based on pharmacotherapeutic considerations of epidemiology, etiology, diagnosis, pathophysiology, and prognosis. P, Biol. 460, Psio. 480 (Identical with Pcol. 475a-475b-475c and Ph.Sc. 475a-475b-475c )
Clinical Pharmacotherapy of Mental Disorders (3) GC I For description, see 889. (Identical with Coun. 489)

Clinical Clerkship
a. Externship (4) II S P, grad. students consult dept. before enrolling.
b. Adult Pharmacy Practice (4) II S P, grad. students consult dept. before enrolling.
c. Ambulatory Pharmacy Practice (4) II S P, grad. students consult dept. before enrolling.
d. Drug/Poison Information (4) II S P, grad. students consult dept. before enrolling.

Note: 503a-d are six-week courses.

Hospital Pharmacy Administration (3) I History, organization and administration of pharmaceutical services within the institutional environment.

Applied Hospital 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.

Interdisciplinary Approaches to Health Care of the Aged (2) S A team approach to problems faced by the chronically ill elderly 3R 4.5L P, consult department before enrolling (Identical with F.C.M. 549), H.R.P. 549, N.F.S. 549.

Physical Parameters for Monitoring Drug Therapy (1) II Introduction to physical assessment skills required of pharmacists for monitoring, assessing, and consulting on drug therapy. 3L. P, CR 575.

Research Methodology and Drug Literature Evaluation (3) II Skills and principles of clinical research design and biostatistics needed for evaluation of the medical literature and writing of research proposals. P, CR 575.

Advanced Pharmacotherapeutics (6) II Advanced concepts for the rational use of drugs in the management of diseases based on pathophysiological, pharmacokinetic, or pharmacologic and toxicologic considerations. 4R, 6L. P, 303e, 410, 475, CR 557. (Identical with Ph.Sc. 575 and Pcol. 575)

Advanced Clinical Pharmacokinetics (3) II For description, see 885.

Seminar
a. Pharmacy Practice (1) [ Rpt./5] I II
b. Pharmacy Practice (Hospital) (1) [ Rpt./5] I II

Pharmacy and Its Environment (3-3) 1985-86 Cultural, social, behavioral, and organizational foundations of pharmacy, including the development of the present state of practice.

Issues In Pharmacy Practice Research (3-3) 1986-87 Survey of research methodology for studying social and behavioral aspects of health care and pharmacy practice; strategy for selecting and modifying existing research tools for particular purposes.

Pharmaceutical Marketing (3) I II Socioeconomic factors in the development, production, and distribution of drugs.

Practicum
a. Clinical Clerkship (1 to 15) [ Rpt.] I II
b. Administrative Clerkship (1 to 15) [ Rpt.] I II

PHILOSOPHY


Associate Professors Henry C. Byerly, Holly M. Smith

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 in philosophy of science and philosophy of law are available.

Applicants should submit scores on the aptitude and advanced (philosophy) tests of the Graduate Record Examination and two letters of recommendation.
The graduate programs are coordinated around a core of courses including logic, epistemology, metaphysics, and ethics. Graduate study programs are individually planned and periodically reviewed in consultation with the Director of Graduate Studies. A brochure describing the programs in detail is available on request from the director.

A thesis is not required for the master's degree but master's students must demonstrate proficiency in logic and pass a final examination. In addition to a dissertation and successful completion of preliminary examinations, doctoral students must pass a qualifying examination and demonstrate proficiency in logic.

403. Foundations of Mathematics (3) GC II 1986-87 (Identical with Math. 403)
414. Philosophical Logic (3) GC 1985-86 Introduction to modal logic; problems of interpretation and application; extensions to such areas as tense logic, epistemic logic, deontic logic.
419. Induction and Probability (3) GC 1986-87 Basic philosophical problems concerning justification of induction, confirmation of scientific hypotheses, and meaning of probability concepts.
421. Philosophy of the Biological Sciences (3) GC 1985-86 Laws and models in biology, structure of evolutionary theory, teleological explanations, reductionism, sociobiology. (Identical with Ecol. 421)
422. Linguistic Semantics and Lexicology (3) GC II 1986-87 (Identical with Ling. 422)
423. Philosophy of the Physical Sciences (3) GC Philosophical problems regarding space, time, motion, relativity, causality, measurement, theoretical entities.
430a-430b. Ethical Theory (3-3) GC 1985-86 430a: Meta-ethics—meaning of moral terms, relativism, subjectivism, ethics and science, social contract theory; 430b: Normative ethics—Utilitarianism, egoism, rights, natural law, justice, deontological duties, blameworthiness and excuses.
434. Social and Political Philosophy (3) GC Fundamental concepts of politics; leading social and political theories, such as anarchism, social contract, Marxism.
438a-438b. Philosophy of Law (3-3) GC 438a Nature and limits of law; law and morality; compensation, contracts, and property; 438b problems about liberty, justice, responsibility, and criminal punishment. (Identical with Pol. 438a-438b)
440. Metaphysics (3) GC Topics include free will and determinism; causation; personal identity; necessity and essence; truth, realism and ontology.
441. Theory of Knowledge (3) GC Critical examination of some of the major problems concerning evidence, justification, knowledge, memory, perception and induction.
450. Philosophy of Mind (3) GC Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, emotion, memory and action.
451. Philosophy of Psychology (3) GC 1985-86 Investigation of philosophical issues arising from current work in psychology including perception, reasoning, memory, motivation and action.
452. Philosophy of Action (3) GC Topics include the explanation of human action; the nature of intentional action; practical reason and deliberation; and the mental antecedents to action, especially desire and belief.
453. Minds and Machines (3) GC 1985-86 Philosophical problems arising from current work in artificial intelligence and cognitive psychology.
455. Philosophy of Language (3) GC Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical form.
464. Semantics (3) GC 1985-86 An investigation of the formal tradition in semantic analysis from Frege, through Tarski to Davidson, Montague and recent trends. (Identical with Ling. 464)
465. Pragmatics (3) GC 1985-86 (Identical with Ling. 465)
470. Greek Philosophy (3) GC [ Rpt. ] Topics in Greek philosophy, to be selected from the pre-Socratics, Plato (Earlier or Later Dialogues) and Aristotle. (Identical with Clas. 470)
PHYSICAL EDUCATION

(See Exercise and Sport Sciences)

PHYSICS


Associate Professors Ke-Chiang Hsieh, Jay E. Treat (Emeritus), Richard A. Young

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in physics. Some interdisciplinary programs such as chemical physics, optics, and astrophysics are also available. Further information regarding these programs may be obtained from the department. 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 adviser 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. As many as three attempts to pass this examination are permitted, but all students must pass it during the first four semesters of residence. Experience in teaching is an essential part of graduate training in physics. Graduate students are required to teach to an amount 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 436, 511 and 515a or the equivalent. Also, each student 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 on the thesis; (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 three of the following courses: 535, 550, 560, 581, 583a, and 685. 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 470a-470b, 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 physics minor adviser early in their graduate work.

Experimental research is conducted in the following areas: elementary particle physics, cosmic rays and space physics, solid state physics, atomic and molecular physics, nuclear physics, carbon dating, surface science, quantum optics, biophysics, and general relativity. Theoretical research is conducted in: solid state physics, atomic physics, nuclear physics, elementary particles, field theory, general relativity, cosmology, satellite and planetary dynamics, and nonequilibrium statistical mechanics. Prospective students should write to the department for information about specific research programs, the faculty involved, the facilities available, and the research and teaching assistantships or fellowship support which can be offered. It is the policy of the department to award financial aid in the form of teaching assistantships solely on the basis of the student's academic record and financial needs. Fellowships are also available to first-year graduate students.

402. Medical Physics (3) GC I Basic physics of the human body: the principles of mechanics, electricity, sound, light, and radiation as they apply to physiology, with emphasis on instrumentation for diagnosis and treatment. P, 102b.

408. Mechanics of Sports (3) GC II Study of sports from a mechanical viewpoint. Necessary concepts of basic mechanics will be developed. Open to nonmajors only. (Identical with Ex.S.S. 408)


412. Theoretical Mechanics II (3) GC II Continuation of 410; mechanics of the continuum; introduction to variational principles; Lagrange's equations. P, 410, Math. 254.

415a-415b. Electricity and Magnetism (3-3) GC Electromagnetic phenomena; Maxwell's equations. P, 410 or Math. 422a.

420. Optics (3) GC II Electromagnetic waves; rays, interference, diffraction, scattering; applications to imaging systems, Fourier methods, holography, and crystal optics. P, 116, 121, Math. 223.

425. Thermodynamics (3) GC II Basic laws of thermal equilibrium; heat engines; ideal and non-ideal gases; phase transitions; Introduction to irreversible processes, kinetic theory, and statistical mechanics. P, 110, 121, Math. 223.

430. Introduction to Biophysics (2) GC 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 Micr. 430)
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<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>433.</td>
<td>Physics Demonstrations (1 to 3) GC II Introduction to teaching materials and lab. 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 phys.</td>
</tr>
<tr>
<td>435.</td>
<td>Introductory Quantum Theory and Atomic Spectra (3) GC I II Introductory quantum mechanics; solutions of the Schroedinger equation for hydrogen-like atoms; perturbation theory; atomic structure; spectra of one and many electron systems; Zeeman-Paschen-Bach effects; hyperfine structure. P, 330, 410, Math. 254; CR 470a or Math. 413 recommended.</td>
</tr>
<tr>
<td>436.</td>
<td>Applications of Introductory Quantum Theory (3) GC II Applications of quantum theory to molecules, atomic nuclei, elementary particles and simple solids. P, 435.</td>
</tr>
<tr>
<td>440a-440b.</td>
<td>Atomic and Molecular Spectroscopy for Experimentalists (3-3) GC 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. (Identical with Opti. 440a-440b)</td>
</tr>
<tr>
<td>450.</td>
<td>Introductory Nuclear Physics (3) GC II Basic concepts of nuclear physics; structure and stability of the nucleus and its components, nuclear forces, nuclear reactions; energy loss of nuclear radiations. P, 330, Math. 254. (Identical with N.E.E. 450)</td>
</tr>
<tr>
<td>460.</td>
<td>Introductory Solid-State Physics (3) GC 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.</td>
</tr>
<tr>
<td>470a-470b.</td>
<td>Methods of Mathematical Physics (3-3) GC 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.</td>
</tr>
<tr>
<td>504.</td>
<td>Introduction to Quantum Optics (3) II (Identical with Opti. 504)</td>
</tr>
<tr>
<td>511.</td>
<td>Analytical Mechanics (3) I Laws of motion as developed by Newton, d'Alembert, Lagrange and Hamilton; dynamics of particles and rigid bodies. P, 410.</td>
</tr>
<tr>
<td>525.</td>
<td>Advanced Thermodynamics and Kinetic Theory (3) II 1985-86 First and second laws of thermodynamics and their applications; Boltzmann transport equation; H-theorem; mean free path methods applied to viscosity, thermal conductivity, and diffusion. P, 425.</td>
</tr>
<tr>
<td>528.</td>
<td>Statistical Mechanics (3) I Physical statistics; the connection between the thermodynamic properties of a macroscopic system and the statistics of the fundamental components; Maxwell-Boltzmann, Fermi-Dirac, Einstein-Bose statistics. P, 470b.</td>
</tr>
<tr>
<td>530.</td>
<td>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 Micr. 530)</td>
</tr>
<tr>
<td>535.</td>
<td>Advanced Atomic Physics (3) II 1986-87 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.</td>
</tr>
<tr>
<td>543.</td>
<td>Laser Physics (3) I 1986-87 (Identical with Opti. 543)</td>
</tr>
<tr>
<td>551.</td>
<td>Satellite and Planetary Perturbation Theory (3) II (Identical with Pty.S. 551)</td>
</tr>
<tr>
<td>556a-556b.</td>
<td>Electrodynamics of Conducting Fluids and Plasmas (3-3) 1986-87 (Identical with Pty.S. 556a-556b)</td>
</tr>
</tbody>
</table>
570a-570b. Quantum Mechanics (3-3) Principles of quantum mechanics; wave mechanics and matrix mechanics; applications to atomic structure and spectroscopy. P, 470a-470b suggested but not required.

575. Advanced Mathematical Methods in Physics (3) I 1986-87 Selections from topics such as functions of complex variables, dispersion relations, group theory, distributions, integral transforms, numerical analysis, approximation theory. P, 470b.

577a-577b. Theory of Relativity (3-3) 1985-86 Special theory of relativity and its application to mechanics and electrodynamics; tensor calculus and general relativity; relativistic astrophysics and cosmology. P, 470b.

579a-579b. Advanced Relativistic Quantum Mechanics (3-3) 1986-87 Continuous groups; scattering theory; relativistic wave equations; quantum electrodynamics, Feynman diagrams, dispersion theory, renormalization; strong and weak interactions. P, 515b, 570b.


581. Elementary Particle Physics (3) II 1985-86 Production, interaction, and decay of mesons, baryons and leptons; high energy scattering of elementary particles; particle classification and symmetries; theoretical interpretation. P, 436.

583a-583b. Thermonuclear Theory (3-3) 583a : II. 583b : I. (Identical with N.E.E. 583a-583b )

585. Stellar Pulsation (1 to 3) [Rpt./5] I II Stellar pulsation, the solar atmosphere, solar seismology and long-term solar variability related to climate.

596. Seminar a. Current Problems in Molecular Biophysics (1 to 3) I II (1) [Rpt.] (Identical with Micr. 596a )

643. Quantum Optics (3) II 1986-87 (Identical with Opti. 643 )

685. Graduate Physics Laboratory (3) [Rpt./2] I 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.


PHYSIOLOGY

(Combat of Medicine)

Associate Professor Andrew M. Goldner
Assistant Professors Janis M. Burt (Research, Surgery), Ziaul Hasan, Patricia B. Hoyer, Richard J. Lemen (Pediatrics), Stephen H. Wright

The department offers a program leading to the Doctor of Philosophy degree with a major in physiology. A Master of Science degree is offered only in rare instances when individuals who have already qualified to study for the Doctor of Philosophy are forced to terminate their graduate education.

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, endocrinology, peripheral vascular physiology, respiratory physiology, gastrointestinal and developmental physiology, membrane transport processes in physiology, and cardiac physiology.

Applicants must have completed the undergraduate major in the physical or biological sciences, in engineering, or in mathematics. Undergraduate preparation should include a minimum of one year of physics, (including laboratory), mathematics through calculus (two semesters), a course in statistics, a course in organic chemistry, familiarity with microcomputers and BASIC language, and an introductory course in biology or zoology. In addition,
physical chemistry and differential equations are highly desirable but not required. The Graduate Record Examination and three letters of recommendation are required to assist in evaluation of applicants.

Graduate study programs are individually planned after consideration of the student’s preparation and special interests. Research facilities are available for studies of the dynamics and control of microcirculation, contraction of muscle and its membrane phenomena, reflex regulation of muscle activity, comparative renal tubule transport and water balance, cellular aspects of transport, reproductive endocrinology and hormone action, development of the gastrointestinal system, cellular and membrane aspects of cardiac function, and the dynamics of respiratory function. In special circumstances, dissertation research may be done outside the department.

Due to the specialized nature of the material and equipment required, some limitation of course enrollments may be necessary. Medical students will be given preference in those courses which are required for the Doctor of Medicine degree program. All other students must consult the department before enrolling. Students already admitted to graduate degree programs in departments of the College of Medicine will be given preference.

418. Physiology for Engineers (4) GC I
   Designed to bring to engineering students an awareness of the structure and function of whole organisms, their component organs, and organ systems. Open to nonmajors only. (Identical with A.M.E. 418, Ch.E. 418 and E.C.E. 418)

419. Physiology Laboratory (2) GC I
   Lab. experiments in physiology intended to provide experience with organ systems and measurement techniques. Designed for engineering students enrolled in the clinical engineering and biomedical engineering options. 6L. Open to nonmajors only. P, 418 or CR. (Identical with A.M.E. 419, Ch.E. 419 and E.C.E. 419)

480. Human Physiology (4) GC II
   Principles of physiology with emphasis on the human; designed primarily for students in pharmacy and health related sciences. Open to pharmacy majors; others consult dept. before enrolling. P, Chem. 243b, Math. 123, Phys. 102b, CR 481. (Identical with Tox. 480)

481. Physiology Laboratory (1) GC II
   Experiments intended to reinforce principles of physiological phenomena; designed primarily for students in pharmacy and health related sciences. Open to pharmacy majors; others consult dept. before enrolling. P, Chem. 243b, Math. 123, Phys. 102b, CR 480. (Identical with Tox. 481)

495. Colloquium
   a. Introduction to the Neurosciences I (2) GC (Identical with Med. 495a, which is home)
   b. Introduction to the Neurosciences II (2) GC (Identical with Med. 495b, which is home)

600. Mathematical Techniques in Physiology (3) GC
   Application of quantitative and analytical mathematical techniques to selected areas of physiology; introduction to mathematical approaches commonly used in physiology. Open to majors and minors; others consult department before enrolling. P, Math. 125a-125b, 160.

601. Human Physiology (8) II
   Principles of physiology, with emphasis on that of the human. P, Chem. 103b, 104b, 241b, 243b; Phys. 102b Consult department before enrolling.

602. Readings in Physiology (2) II
   Designed to provide students with more detailed consideration of various organ systems than can be provided in 601. Open to majors and minors only. P, Chem. 103b, 104b, 241b, 243b, Phys. 102b, CR Psio. 601.

605. Neurosciences (6) II (Identical with Anat. 605)

606. Readings in Neuroscience (2) II
   Essentials of mammalian neural structure and function. Open to majors and minors only. Not recommended for students whose major interests lie in the neurosciences.

610. Research Methods in Physiology (1 to 3) [ Rpt.] II
   Lab. course stressing the principles of physiological research.

696. Seminar
   a. Advanced Mammalian Physiology (1 to 4) [ Rpt./1] II Open to majors and minors only. P, 600, 601, 602; 606 or Anat. 605.
   b. Literature (1) [ Rpt./5] II Open to majors only. P, 600, 601, 602; 606 or Anat. 605.

801. Human Physiology (8) II

805. Neurosciences (6) II (Identical with Anat. 805)
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 experimental, observational, and theoretical study of planetary atmospheres; the interiors of the planets and satellites; asteroid and cometary astronomy and physics; the surfaces of the moon, terrestrial planets, and outer-planet satellites; meteoritics, lunar science, and problems of plasma physics associated with cosmic rays; the solar wind and its interaction with solar system bodies. Students are normally admitted to the doctoral program only. In certain circumstances, however, the Master of Science degree may be an appropriate intermediate or terminal degree.

Applicants should have completed the undergraduate major in a physical science such as astronomy, atmospheric sciences, chemistry, geology, or physics. Applicants must submit scores on the aptitude and advanced (chemistry, geology, or physics) tests of the Graduate Record Examination and names of three references. When possible, personal or telephone interviews are desirable.

The minor shall consist of at least 12 units in one of the following departments: mathematics, physics, chemistry, geosciences, or optical sciences. The majority of the courses should be 500 level or above and a "B" average must be maintained.

Degrees

MASTER OF SCIENCE — This program is available only in special circumstances. At least eighteen units in the major core program and a thesis suitable for publication are required.

DOCTOR OF PHILOSOPHY — All students must complete the fifteen-unit core program consisting of 505a-505b, 510, 517, and 554 (though exceptionally well-prepared students may have a portion of this requirement waived). An additional minimum of 21 units must be completed in a specialized area of planetary sciences. A specified competence in a modern foreign language is required. Students are expected to complete all requirements for the degree within three to four years following successful completion of the preliminary examination.

The Department of Planetary Sciences and the Lunar and Planetary Laboratory are active participants in many missions of the NASA space science program. The laboratory’s Space Imagery Center contains one of the most extensive collections of lunar and planetary photography in the world, including Ranger, Surveyor, Orbiter, and Apollo photography of the Moon; Mariner and Viking imagery of Mars; Mariner 10 imagery of Venus and Mercury; and Pioneer 10 and 11 and Voyager results for Jupiter and Saturn — all of which are available to students for research purposes. Also available for student research are the facilities of the University of Arizona’s observatories, including 154cm, 1.5m, 1.0m, and 0.7m reflectors in the Santa Catalina Mountains north of Tucson, and 229cm, 0.9m, and 0.5m reflectors on Kitt Peak west of Tucson, as well as the Multiple Mirror Telescope on Mt. Hopkins, which is a joint project of the University of Arizona and the Smithsonian Astrophysical Observatory. Laboratory facilities for cosmochemistry and geochemistry include a scanning electron microscope, an experimental petrology laboratory, a radiochemistry separation laboratory, and a neutron activation analysis laboratory. The laboratory also maintains a state-of-the-art VICOM digital image processing system. A nuclear reactor located on campus and counting facilities in the Lunar and Planetary Laboratory are available for isotope research and activation analysis.

The University has a well-equipped computer center with CDC Cyber, VAX 11/780, and DECSYSTEM-10 computers. The Lunar and Planetary Laboratory maintains a number of
special-purpose computers, which can be used interactively for such special applications as
inversion of Fourier interferograms and reduction of data from various space programs, and
other student research projects.

403. Introduction to the Solar System (3) GC I Survey of planetology; origin of planets; asteroids;
meteorites; interplanetary dust and gas; planetary interiors; geophysics; planetary atmospheres;
origin of life. Advanced degree credit available only with departmental permission. P, Phys. 103a-103b. (Identical with Astr. 403 and Geos. 403)

404. Exploration of the Solar System (3) GC I S Primitive astronomy to modern space exploration;
planetary science fundamentals, solar system physical properties; planetarium demonstrations,
classroom projects. Field trip. Advanced degree credit available only with departmental permi-
sion. (Identical with Astr. 404)

419. Physics of the Earth (3) GC I (Identical with Geos. 419)

505a-505b. Principles of Planetary Physics (3-3) Interplanetary plasmas; transport properties of
planetary matter; introduction to celestial mechanics. Applications of geophysics, fluid mechan-
ics, and statistical physics to planetary interiors, surfaces and atmospheres. P, Phys. 435.

510. Principles of Cosmochemistry (3) I 1986-87 Chemical compositions of solar system objects;
equilibrium and nonequilibrium chemical processes applied to planets; cosmochronology. P, 403,
Chem. 480a-480b.

517. Planetary Atmospheres (3) I 1985-86 Survey of compositions, temperature and density profiles,
chemistry, condensation products, spectroscopic evidence; circulations and heat budgets; evolu-
tion and origin of planetary atmospheres. P, 403.

energy; remote optical methods and direct sampling techniques; error analysis and ultimate limits
to system performance; numerical procedures; laboratory experiments in cosmochemistry,
absorption spectroscopy and IR detector technology. 2R, 3L. P, introductory physics and cal-
culus. (Identical with Atmo. 518 and Astr. 518)

520. Meteorites (3) II 1986-87 Classification; chemical, mineralogical and isotopic composition; cos-
mic abundances; ages; interaction with solar and cosmic radiation; relation to comets and
asteroids. P, 510. (Identical with Geos. 520)

527. Advanced Geochemistry (3) I (Identical with Geos. 527)

528. Nuclear Geology (3) II 1986-87 (Identical with Geos. 528)

544. Physics of the High Atmosphere (3) II 1985-86 Physical properties of the upper atmosphere,
including gaseous composition, temperature and density, ozonosphere, and ionosphere, with
emphasis on chemical transformations and eddy transport. (Identical with Atmo. 544)

551. Satellite and Planetary Perturbation Theory (3) II Two- and three-body problems; potential
theory; Lagrange's planetary perturbation equations; methods of solution, applications; gravity-
gradient torque; attitude stability; lunar libration; tidal interactions; lunar evolution. P, Math. 254,
Phys. 410. (Identical with Astr. 551 and Phys. 551)

554. Evolution of Planetary Surfaces (3) II 1986-87 The geologic processes and evolution of ter-
restrial planet and satellite surfaces including the Galilean and Saturnian satellites; implications
for the early history of the Earth. P, 311, 403. (Identical with Geos. 554)

556a-556b. Electrodynamics of Conducting Fluids and Plasmas (3-3) 1986-87 Plasma physics and
magnetohydrodynamics. 556a : Introduction; discussion of the sun, solar wind, magnetosphere,
with Astr. 556a-556b and Phys. 556a-556b)

565. Jovian Planets and Satellites (3) I 1986-87 Observational data; atmospheric structure and
composition; thermal balance; mass, radius, flattening; physics of light elements at high pres-
ures; structure of rotating planets; origin of magnetic fields. P, 403.

567. Inverse Problems in Geophysics (3) I 1986-87 (Identical with Geos. 567)

571. Constitution and Evolution of the Terrestrial Planets (3) I 1985-86 Composition and evolution
of terrestrial planets; includes the Moon, asteroids, meteorites, other evolved rocky satellites;
geophysical/geochronological techniques used to deduce histories. (Identical with Geos. 571)

596. Seminar
PLANNING

Committee on Planning (Graduate)

Professors Arthur L. Silvers (Management and Policy), Chairperson, Lay J. Gibson (Geography & Regional Development), Robert Giebner (Architecture), Frank Gregg (Renewable Natural Resources), David A. King (Renewable Natural Resources), James S. Lincon (Management and Policy), Kirby W. Lockard (Architecture), Lawrence D. Mann (Geography & Regional Development), Fred S. Matter (Architecture), Richard L. Medlin (Architecture), Thomas F. Saarinen (Geography & Regional Development), Norman Williams, Jr. (Geography & Regional Development)

Associate Professors Stanley K. Brickler (Renewable Natural Resources), Harry der Boghosian (Architecture), Theodore H. Koff (Management and Policy), Gordon F. Mulligan (Geography & Regional Development), Ronald J. Vogel (Management and Policy)

Assistant Professors Robert Itami (Renewable Natural Resources), David Plane (Geography & Regional Development)

The Committee on Planning offers graduate professional programs leading to the Master of Science degree with a major in planning.

Concentrations are offered in the fields of policy and planning (Management and Policy; College of Business and Public Administration) and in regional planning (Geography; Faculty of Social and Behavioral Sciences). Additional concentrations currently under development are in community design (College of Architecture) and natural resources planning (School of Renewable Natural Resources). All students pursuing the M.S. with a major in planning are required to complete a basic core program consisting of fifteen units. The core includes Ping. 457, 602, 605, 609 and 612b.

The concentration in policy and planning provides training for a variety of staff-level careers in state and local government. Competence in problem solving in the public sector is strengthened by combining analytic, computer, financial and social science courses with hands-on experience through workshops and field internships. Areas of specialization are land use and the environment, health care, services for the elderly and public facility planning. In addition to the basic core, students in the concentration in policy and planning must complete M.I.S. 501, Ping. 612a, Econ. 500a, M.A.P. 610a, 693g, and Ping. 608.

The concentration in regional planning provides a strong grounding in location and spatial analysis, environmental behavior, and in legal/political institutions for regional infrastructure and development planning. Students are involved in actual field applications and are exposed to professional and faculty expertise. Areas of specialization are land use and the environment, regional development, techniques for regional analysis, and transportation and human interaction. In addition to the basic core, students in the program in regional planning must complete Ping. 503, 556, 567, 608 and 659.

453. Industrial Location Analysis (3) GC II (Identical with Geog. 453)
456. Urban Geography (3) GC I (Identical with Geog. 456)
457. Statistical Techniques in Geography and Planning (3) GC I (Identical with Geog. 457)
461. Population and Resources (3) GC I (Identical with Geog. 461)
463. Program Planning for Human Services (3) GC II (Identical with M.A.P. 463)
468. Urban Transportation Planning (3) GC II (Identical with C.E. 468)
471. Problems in Regional Development (3) GC I II (Identical with Geog. 471)
474. Geology and the Urban Environment (3) GC I II (Identical with Geos. 474)
481. Computer Cartography (3) GC II (Identical with Geog. 481)
483. Geographic Applications of Remote Sensing (3) GC II (Identical with Geog. 483)
485. Zoning Fundamentals (3) GC I (Identical with M.A.P. 485)
DEPARTMENTS AND COURSES OF INSTRUCTION

506. Fundamentals of Physical Planning (3) I (Identical with M.A.P. 506)
507. Social Service Planning (3) I (Identical with M.A.P. 507)
510. Development of Regional Planning (3) I (Identical with Geog. 510)
511. Metropolitan and Regional Planning (3) I (Identical with Geog. 511)
556. Urban Systems Analysis (3) II (Identical with Geog. 556)
557. Spatial Analysis (3) II (Identical with Geog. 557)
561. Resource Management (3) I (Identical with Geog. 561)
563. Perception of Environment (3) I II (Identical with Geog. 563)
565. Quick Response Transportation Planning Methods (3) I 1985-86 (Identical with C.E. 565)
568. Urban Public Transportation Systems (3) I 1986-87 (Identical with C.E. 568)
575. Housing and Residential Areas (3) II (Identical with M.A.P. 575)
596. Seminar
   u. Interdisciplinary Environment-Behavior-Design (3) I (Identical with Idis. 596u, which is home)
602. 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, 457 or M.A.P. 552. (Identical with M.A.P. 602)
605. Planning Theories and Perspectives (3) I (Identical with Geog. 605)
608. Planning Law (3) II (Identical with Geog. 608)
609. Policy Problems In Structure and Change (3) II (Identical with M.A.P. 609)
611. Projects in Regional Planning (1 to 5) [Rpt./5 units] II (Identical with Geog. 611)
612a-612b. Projects in Policy and Planning (2-3) (Identical with M.A.P. 612a-612b)
651. Health and Public Policy (3) I II (Identical with M.A.P. 651)
655. Efficiency Analysis in Health Administration (3) II (Identical with M.A.P. 655)
659. Growth Controls (3) II (Identical with Geog. 659)
662. Aging and Public Policy (3) I (Identical with M.A.P. 662)
669. Preservation of Historic Environments (3) II 1985-86 Current planning and legal methods to enhance the preservation of historic urban areas and structures; concentrated analysis of selected case studies. Field trips. (Identical with Law 669)
693. Internship
   g. Policy and Planning (1 to 4) S (Identical with M.A.P. 693g, which is home)
696. Seminar
   h. Land-Use Regulation (3) I II (Identical with M.A.P. 696h, which is home)
   i. Legal Inquiry in Policy and Planning (3) II (Identical with M.A.P. 696i, which is home)
   j. Environmental Planning (3) I II (Identical with M.A.P. 696j, which is home)
   k. Planning Administration (3) I II (Identical with M.A.P. 696k, which is home)
   o. The General Plan (3) [Rpt./6 units] I II (Identical with Geog. 696o, which is home)
   p. Alternative Urban Futures (3) [Rpt./6 units] I II (Identical with Geog. 696p, which is home)

PLANT PATHOLOGY

Professors Merritt R. Nelson, Head, Stanley M. Alcorn, Ross M. Allen (Emeritus), Alice M. Boyle (Emerita), Robert L. Gilbertson, Richard B. Hine, Michael A. McClure, Edward L. Nigh, Michael E. Stanghellini
Associate Professors H. Earl Bloss, Iraj J. Misaghi
Assistant Professor Alan J. Howarth

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in plant pathology. Concentrations are available in bacteriology, mycology, nematology, virology, physiology of parasitism, genetics of pathogens, diseases of economically important plants and soilborne fungi.
Applicants should have a background in the botanical sciences and undergraduate credit in college algebra (calculus is also recommended), microbiology, genetics, physics, and a year course in organic chemistry.

At least fifteen units in plant pathology 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.

402. Introduction to Pesticides and Their Use (2) GC II Overview of pesticide use, with emphasis on interaction of technical, societal, individual, and regulatory aspects of the choices; specific control recommendations not stressed. (Identical with Ento. 402, PI.S. 402, and S.W. 402)


451. Diagnosis and Control of Plant Diseases (3) GC I Field and lab. course designed to give students familiarity with diagnosis of plant diseases and plant disease control concepts. 2R, 3L. All-day field trips. P, 206. (Identical with Micr. 451)

516. Plant Nematology (3) II 1986-87 Comprehensive course in plant nematology, including the nature, ecology, and classification of plant parasitic nematodes. Diagnosis and control of nematode diseases of plants. 2R, 3L. P, 205.

520. Analytical Techniques for Phytopathological Research (4) II Techniques, including chromatography, electrophoresis, spectroscopy, and immunology. 2R, 6L. P, 206.

575a-575b. General Mycology (3-3) 1986-87 Comprehensive study of fungi, including their structure, function, classification, genetics, and ecological importance. 575a: Basidiomycetes and Fungi Imperfecti. 575b: Myxomycetes, Phycomycetes, and Ascomycetes. 2R, 3L. P, Ecol. 104 or PI.S. 100. 575a is not prerequisite to 575b.

596. Seminar
   a. Current Research (1 to 3) I


694. Practicum

PLANT PROTECTION

Committee on Plant Protection (Graduate)

Professors Thomas C. Tucker (Soils, Water and Engineering), Chairperson, Stanley M. Alcorn (Plant Pathology), Keith C. Hamilton (Plant Sciences), Michael E. Stanghellini (Plant Pathology), Theo F. Watson (Entomology)

Associate Professors Paul M. Bessey (Plant Sciences), Dennis L. Larson (Soils, Water and Engineering)

The Committee on Plant Protection, an interdepartmental committee in the College of Agriculture, offers a program leading to the Master of Science degree with a major in plant protection.
Concern in contemporary society for the quality of our environment has led to legislation on the use and applications of many chemicals used in the management of agricultural pests. The program provides the broad training that will be needed by individuals to apply and make recommendations for chemicals used to control insects, diseases, and weeds in integrated systems of pest management. The primary objective of this program is to impart the philosophy that plant protection is based on the integration of all known control measures (biological, cultural, chemical) designed to maintain pest densities below economically damaging thresholds while producing a minimal impact on the environment.

Successful applicants may be from any undergraduate discipline provided that they have an appropriate background in the physical and biological sciences. Financial assistance is not available through the Committee on Plant Protection.

Students will be assigned to an adviser in one of the participating departments, chosen on the basis of the student's interest and area of concentration. All students are required to complete Ento. 410, 430 and one additional unit; PI.P. 402 and 451; PI.S. 405; S.W.602; three units of biometry; three to six units of either 599/699, 900, or 910; and one to three units of either 595, 596, or 696. In addition, the student's guidance committee may approve additional courses such as Agri. 493; M.C.B. 460; Ecol. 472; Ento. 432, 436, and 438; PI.S. 408; or A.En. 450 and 451.

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**PLANT SCIENCES**


Associate Professors Paul M. Bessey, Kaoru Matsuda, Hiroshi Muramoto

Assistant Professors Alan H. Goldstein, Wallace C. Hofmann, Janice M. Kobriger, Chi Won Lee, John W. Moon, David A. Palzkill, Steven E. Smith

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in agronomy and plant genetics or in horticulture. Concentrations are available in physiology, ecology, plant breeding, genetics, weed science, and agronomic and horticultural production.

Applicants must have completed an undergraduate major in agriculture or biology, including at least sixteen units in plant sciences or closely related fields. The undergraduate program must have included basic courses in botany, genetics, entomology, plant pathology, and soils. Applicants should arrange to have three letters of recommendation sent to the graduate coordinator.

Prospective applicants should consult the graduate coordinator for specific requirements in their areas of proposed concentration. The decision to require or waive the requirement for the master's thesis will be made by the department after consideration of the student's preparation, proposed graduate program, and professional objectives.

402. *Introduction to Pesticides and Their Use* (2) GC II (Identical with PI.P. 402)

405. *Weed Control* (3) GC I Principles and effects of controlling agronomic, horticultural, and range weeds, with emphasis on chemical control methods; weed identification. 2R, 3L. P, 6 units of PI.S. Hamilton

408. *Crop Ecology* (3) GC 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, 110 Briggs

421. *Field Plot Research* (3) GC I Principles of field plot research, with emphasis on procedures in small plot experimentation, such as the laying out of experiments, size and shape of plots, border effects, collection of data, and the summarization and publication of results. 2R, 3L, P, Math. 117e.

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
<th>Prerequisites</th>
<th>Credits</th>
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<tbody>
<tr>
<td>466</td>
<td>Postharvest Physiology (3) GC II 1985-86</td>
<td>Postharvest physiology, grading, packing, storage, transportation and handling of fruits, vegetables and other horticultural products. P, Chem. 241a, Ecol. 260 or M.C.B. 460. (Identical with N.F.S. 466)</td>
<td>Chem. 241a</td>
<td>3</td>
</tr>
<tr>
<td>516</td>
<td>Genetic Principles of Hybrid Seed Production (3)</td>
<td>Genetic and cytogenetic principles applied to the development and maintenance of inbreds and to the production of hybrid seed. P, 312 or Ecol. 320 or 321.</td>
<td>Ecol. 260</td>
<td>3</td>
</tr>
<tr>
<td>528</td>
<td>Plant Microtechnique (4)</td>
<td>Theory and practice of plant histological technique, including the use of light and electron microscopes and accessory equipment. P, twelve units of plant sciences or biology. Bartels</td>
<td>Chem. 241a</td>
<td>4</td>
</tr>
<tr>
<td>562</td>
<td>Plant Intermediary Metabolism (3)</td>
<td>Principles of hybrid seed production (3) 1985-86 (Identical with M.C.B. 562)</td>
<td>Ecol. 260</td>
<td>3</td>
</tr>
<tr>
<td>567</td>
<td>Advanced Genetics (3)</td>
<td>Strand and tetrad analysis; chromosome structure and organization; recombination at the molecular level and gene conversion; mutation classifications and orgins; genetic complementation and its relation to a genetic unit and its function. P, 312 or Ecol. 320 or 321. Endrizzi</td>
<td>Ecol. 260</td>
<td>3</td>
</tr>
<tr>
<td>568</td>
<td>Crop Physiology (3)</td>
<td>I Plant processes and environmental interactions in relation to growth and production of crop communities, with emphasis on recent advances and research techniques. P, Ecol. 260 or M.C.B. 460.</td>
<td>Ecol. 260</td>
<td>3</td>
</tr>
<tr>
<td>569</td>
<td>Theory of Plant Breeding (3)</td>
<td>Critical study of the theoretical basis for plant breeding procedures. P, 315 or An.S. 413 and Agri. 539.</td>
<td>An.S. 413</td>
<td>3</td>
</tr>
<tr>
<td>570</td>
<td>Quantitative Genetics and Selection (3)</td>
<td>Biological approach to the principles of quantitative inheritance as applied to the selection of quantitative characters in breeding experiments, with emphasis on the methods of measuring, analyzing, and interpreting quantitative data. P, three units of gene.</td>
<td>Agri. 539</td>
<td>3</td>
</tr>
<tr>
<td>571</td>
<td>Advanced Cytogenetics (4)</td>
<td>Fundamental principles that illustrate the correlation of genetic and cytological features involving intra- and interchromosomal structural changes, heterploidy and species hybrids. 3R, 3L. P, 6 units of gene. Endrizzi</td>
<td>Ecol. 260</td>
<td>4</td>
</tr>
</tbody>
</table>
| 601        | Seminar                                                                       | a. Agronomy (1) [Rpt/2] II  
  b. Horticulture (1) [Rpt/2] II                                                                                                                                        |              |         |

**POLITICAL SCIENCE**

Professors Jerrold G. Rusk, Head, James A. Clarke, Richard C. Cortner, Vine Deloria, Jr., Rosendo A. Gomez (Emeritus), Helen M. Ingram, Conrad F. Joyner, Paul Kelso (Emeritus), Clifford M. Lytle, Edward N. Muller, Peter A. Toma, John C. Wahlke, Allen S. Whiting, Edward J. Williams, Clifton E. Wilson


Assistant Professors Thomas M. Holm, Lyn Ragsdale

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in political science. Concentrations are available in political theory, American political institutions, public policy, political behavior, international relations, comparative politics, and American Indian policy studies. The Master of Arts degree is designed as a basis for students who 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 select an area or two subareas of concentration from those listed above and complete up to 24 units of course work 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.

406. **Bureaucracy** (3) GC I Analyses of legal, political, cultural and behavioral aspects of public organizations, bureaucratic typologies and methods of public control.

407. **Congress and American Politics** (3) GC I II Examination of election politics, personalities and career patterns of Congress members, the organization and structure of Congress, and the role of Congress in policy leadership and representation of the public.

409. **Struggle for the Presidency** (3) GC I Examination of the campaign strategies and tactics of those seeking the nation's most powerful office from 1960 to the present through films and readings.

412. **Local Government and Administration** (3) GC I II Examination and analysis of local decision-making structures and their policy outputs. P. 103.

421. **Recent Political Thought** (3) GC I II Political theory from Marx to the present.

426. **American Political Thought** (3) GC II American political ideas from colonial times to the present.

431. **Political Culture and the Dynamics of Change in American Society** (3) GC 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.

432. **Pressure Groups** (3) GC I II 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.

434. **Quantitative Analysis of Political Problems** (3) GC I Introduction to the use of statistics on political data, with emphasis on statistical manipulation; evaluation and interpretation of statistical explanations of political phenomena.
Political Science 285

435. Public Opinion and Voting Behavior (3) GC I II Attitude and opinion formation and socialization; public opinion in the political process; the relationship between attitudes, opinion and voting behavior in American politics. (Identical with Soc. 435)

436. Personality and Politics (3) GC II Examination of the theories and concepts associated with the psychological basis of various types of political behavior.

437. Democracies, Emerging and Evolving (3) GC I Causal analysis of conditions of stability and breakdown of democratic regimes with particular emphasis on the developing democracies of the third world.

438a-438b. Philosophy of Law (3-3) GC (Identical with Phil. 438a-438b)

440. Politics and Mythology (3) GC I The role of the non-rational/irrational in politics: cults, utopias, crusades, conspiracies, cultural revitalization movements.

442. Transformation of Agrarian Societies in the Middle East (3) GC II (Identical with Or.S. 442)

443. Soviet Politics (3) GC I Revolution and contemporary ideology; state, party and mass organizations; economic and social planning; civil liberties; models of autocracy and pluralism.

444. East European Politics (3) GC II Divergent models of Communist development, from East Germany to Yugoslavia; political, economic, social and cultural reform.

445. Comparative Political Revolution (3) GC I Examination of the causes and consequences of 20th-century revolutions and the revolutionary process, with emphasis on contemporary events.

446. Politics of Developing Areas (3) GC II Survey of politics and problems in Asia, Africa, and Latin America, including political violence, elections, bargaining, elites, parties, the military and ideology.

447. Latin-American Political Development (3) GC II Presentation of strategies for development in Latin America; examination of case studies from Cuba, Brazil, Chile, Guatemala, and other countries.

448. Government and Politics of Mexico (3) GC I Description and analysis of Mexico’s political economy, its political system, and its foreign policy, with emphasis on Mexican-U.S. relations. (Identical with M.A.S. 448)

449. The Politics of Cultural Conflict (3) GC II Comparative examination of the approaches of different types of political systems to domestic conflict of a racial, religious, lingual and/or ethnic nature.

451. Soviet Foreign Policy (3) GC I Ends and means of Soviet foreign policy; the decision-making process; Soviet relations with the West and developing nations.

452. Communist Foreign Relations (3) GC II Interrelations of fourteen Communist-party states, with emphasis on cooperation and conflict in such organizations as the Comecon and the Warsaw Pact.

454. Theories of International Relations (3) GC 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.

455. American Foreign Policy (3) GC I II Analysis of the Cold War; Congressional-Executive clashes over foreign policy control; approaches to policy analysis.

456a-456b. International Law (3-3) GC 456a: The international state system; legal-political problems, including territory, environment, seas. 456b: The international system and the individual; the war system, including use of force, laws of war. 456a is not prerequisite to 456b.

457. Inter-American Politics (3) GC I Survey and analysis of the leading political and economic issues at controversy between the United States and Latin America.

458. Government and Politics of the Middle East (3) GC II (Identical with Or.S. 458)

459. Problems of World Order (3) GC II Analysis of complex, interrelated global problems, threats to survival, quality of life and exploration of past and present policies and future worlds. Course is value-oriented and prescriptive.

460. Modern Chinese Foreign Relations (3) GC 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 Or.S. 460)
461a-461b. Chinese Politics, 1911-Present (3-3) GC Analysis of the political, economic, and social structure in China, with particular emphasis on the role the Communist party plays in society. 461a: 1911-1949. 461b: 1949-present. (Identical with OR-S/461a-461b)

464. International Relations of East Asia (3) GC II National interests, issues and conflicts, relations, and influence of domestic politics in interstate relations in East Asia. (Identical with Or.S. 464)


471. Constitutional Law: Civil Liberties (3) GC I II Analysis of the constitutional guarantees of civil liberties in the U.S.

474. Administrative Law (3) GC 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.

475. Concepts in Criminal Law (3) GC II Focus on questions such as what constitutes a crime; when is killing murder; what makes punishment just; what distinctions exist between justifiable and excusable crimes.

476. Women and the Law (3) GC I 1986-87 Legal status of women in America, including constitutional protections, marriage and family relationships, educational and vocational opportunities, political rights, criminal law. (Identical with W.S. 476)

480. Formulation of Public Policy (3) GC I Needs and demands for public action on policy issues; organization and nature of political support; processes and problems of decision making in the formulation of public policy at the national, state, and local levels.

481. Environmental Policy (3) GC II Role of government in management of energy, natural resources and environment; process and policy alternatives; special attention to the Southwest. (Identical with OR.W. 481)

483. Urban Public Policy (3) GC I II Analysis and discussion of social, economic, and political problems and proposed solutions in changing urban environments.

484a-484b. Development of Federal Indian Policy (3-3) GC 484a: European colonial precedents through the treaty-making period. 484b: End of treaty-making to the present. 484a is not prerequisite to 484b. (Identical with A.In.S. 484a-484b)

485. National Security Policy (3) GC I Decision-making structures, processes and outcomes relevant to American security policy; comparison with major foreign powers.

486. Political Systems of India and Pakistan (3) GC II (Identical with OR.S. 486)

487. Race and Public Policy (3) GC I Examination of the race issue in the context of American politics, from historical, behavioral, and comparative perspectives. (Identical with A.In.S. 487 and Bi.S. 487)

489. The Politics of National Policymaking (3) GC I II Analysis of institutional and political basis for cooperation and conflict between Congress, the president, and the Court in different policy areas.

579. Research Design (3) I Introduction to experimental and quasi-experimental research design; survey research; the use of aggregate statistics; historical documents and life-history materials; participant observation; obtrusive methods.

580. Methods of Political Inquiry (3) I II 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.

582. Research and Methodology (4) II Quantitative techniques and computer applications in political science.

585. Political Risk and Intelligence Analysis (3) II Examination of political risk and intelligence analysis with emphasis on forecasting political developments in nations.

595. Colloquium
   a. American Political Institutions (3) I II
   b. Political Behavior (3) I II
   c. Survey of Political Theory (3) I II
   d. Comparative Politics (3) I II
   e. International Relations (3) I II
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
   e. International Relations (3) [ Rpt./2] I II
   f. Public Law and the Judicial Process (3) [ Rpt./2] I II
   g. Public Policy (3) [ Rpt./2] I II
   h. American Indian Law and Policy (3) [ Rpt./2] I II (Identical with A.In.S. 596h )

610a-610b. Fiscal and Budgetary Administration of Public Agencies (3-3) (Identical with M.A.P. 610a-610b )

PORTUGUESE
(See Spanish and Portuguese)

PSYCHOLOGY

Professors Lee Sechrest, Head, Neil R. Bartlett, Robert B. Bechtel, Larry E. Beutler
(Psychiatry), Richard W. Coan, Terry C. Daniel, George Domino, Sigmund Hsiao,
William H. Ittelson, Marvin W. Kahn, James E. King, Robert W. Lansing, Peter
Madison, Dorothy I. Marquart, Ralph M. Reitan, Bruce D. Sales, Mary C. Wetzel,
David B. Wexler (Law), Lawrence Wheeler, Robert L. Wrenn

Associate Professors Harold S. Arkowitz, Philip Balch, Wayne R. Carroll, Lewis Hertz, Alfred
W. Kaszniaik (Psychiatry), Spencer A. McWilliams, Ronald H. Pool, William H.
Thweatt

Assistant Professors Jeff L. Greenberg, George P. Knight

The department offers programs leading to the Master of Arts and the Doctor of
Philosophy degrees with a major in psychology. Concentrations are available in clinical
psychology, environmental psychology, biological bases of behavior (physiological and neu-
rological psychology, sensory and motor processes, psychopharmacology, and comparative
psychology), cognitive-affective bases of behavior (learning, motivation, emotion, cognition,
language and communication, and perception), social bases of behavior (group processes,
organizational and systems theory and leadership), and individual bases of behavior (develop-
mental psychology, adolescent behavior, aging processes, personality, and psycho-
pathology). Appropriate minor programs, including one in law, are available.

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.

The graduate program will be planned in consultation with the major and minor
advisory committees. The curriculum for students selecting a concentration in clinical psy-
chology is more formalized than that for students with different concentrations, and it
requires the completion of a one-year internship at an approved agency.

The program for the Master of Arts degree includes courses, demonstrations of com-
petence in qualifying examinations, and the presentation of a thesis. The degree is not a
terminal one; rather, it is usually preparatory to entering the doctoral degree program.

400. Neurological Psychology (3) GC I II Group discussion, demonstrations and experiments on
current problems in neuropsychology. Problems selected to permit students to integrate labora-
tory techniques, research literature, and anatomical and physiological knowledge with behavioral

401. Body Chemistry and Behavior (3) GC I Biochemical compounds related to life and the role of
behavior in life; chemical processes occurring within organisms and how they interact with
behavior. P, 101; and 302 or 8 units of bio. lab. sci.
288 DEPARTMENTS AND COURSES OF INSTRUCTION

403. Biopsychology (3) GC II Functions of the brain and other bodily systems in reflex and learned control of movement and perceptual responses; emotional effects and experiences, sleep, and language. P, 101, 302.

404a-404b. Human Brain-Behavior Relationships (3-3) GC 404a: Brain functions in relation to intelligence, speech, memory, judgment and reasoning, and visual-spatial abilities. P, 302. 404b: Continuation of 404a; methods of examination of human brain functioning in relation to individual differences in both normal and brain-damaged persons.

410. Advanced Social Psychology (3) GC I II Social psychology, with emphasis on theory and method. P, 245, 300.

411aR-411bR. Comparative Psychology (3-3) GC Systematic study of animal behavior. 411aR: Analysis of environmental and genetic determinants of behavior, special behavioral adaptations in animals, and sociobiological concepts. 411bR: Animal learning with emphasis on interspecies comparisons. 411aR is not prerequisite to 411bR. P, 101.


414L. Advanced Developmental Psychology Laboratory (1) GC I II Applications of developmental psychology in lab. and natural settings. P, 101; 414R or CR.

416. Personality (3) GC I II Advanced study of theories of personality; methods and results of personality study. P, 101, 245.


421. Psychology of Death and Loss (3) GC I II Basic concepts in a psychology of death and loss, with emphasis on both the adjustment to death and loss, and the underlying phenomenal, humanistic and current social considerations. P, 101.


428. Field Methods in Environmental Psychology (3) GC 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. P, 371. (Identical with Arch. 428 and L.Ar. 428)

430a-430b. Psychology, Law and Social Policy (3-3) GC Critical review of theory, methods and research in the psychology, law and social policy interface. P, 101. 430a is not prerequisite to 430b.

435. Psychological Problems of the Aged (3) GC I Cognitive, intellectual, personality, and behavioral correlates of aging; relates general psychological theory to the problems of aging. P, 101 or grad. standing. (Identical with Gero. 435)


458. Psychopathology (3) GC II In-depth study of current theoretical and research formulations in behavior deviancy; various approaches to behavior change. P, 418.

472. Human Memory and Cognition (3) GC II Human learning, memory, and cognition; emphasis on information-processing approach to results and theory. P, 101, 245, 370; or grad. standing.

475. History of Psychology (3) GC 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. P, 101, 255.

481. Topics in the Biological Bases of Behavior (3) [ Rpt./1] GC I II Variable content (consult schedule); physiological, neurological, sensory, and motor systems; comparative psych., others. P, 101 and six units upper-div. psych.; or grad. standing.

482. Topics in the Cognitive and Affective Bases of Behavior (3) [ Rpt./1] GC I II Variable content (consult schedule); learning, cognition, perception, psycholinguistics, emotion, others. P, 101 and six units upper-div. psych.; or grad. standing.
483. Topics in Social Bases of Behavior (3) [Rpt./1] GC II Variable content (consult schedule): group processes, organizational theory, leadership, others. P, 101 and six units upper-div. psyc.; or grad. standing.

484. Topics in Individual Bases of Behavior (3) [Rpt./1] GC II Variable content (consult schedule): developmental psychology, personality, psychopathology, others. P, 101 and six units upper-div. psyc.; or grad. standing.


507a-507b. Statistical Methods in Psychological Research (3-3) 507a: Research design, application of analysis of variance, multiple comparisons, and computer techniques in psychological research. 507b: Selected methodological issues and multivariate methods in psychology, with coverage of computer applications. Open to psychology majors only.

509. History of Psychological Theories and Research (3) II Development of psychology as a science; schools, systems, theories, major advances, famous investigators.

520a-520b. Theory and Research in Biopsychology (3-3) [Rpt./1] 520a: Review of current theories and research in biopsychology. 520b: Research methods for the study of biological processes and behavior; emphasis on current techniques and instrumentation for stimulus control, recording and analyzing behavioral data, and psychopharmacological studies. P, 403.

521a-521b. Theory and Research in Environmental Psychology (3-3) Advanced topics in environmental psyc. 521a: Emphasizes research and application. 521b: Emphasizes methodology.


550. Theory and Research Methods in Developmental Psychology (3) I Major theories and research methods in contemporary developmental psychology.

551. Social/Personality Development (3) II 1986-87 Theories and research in the development of social behavior patterns and personality.

552. Child Language Development (3) II 1985-86 Advanced theories and research related to children's acquisition of their native language.

555. Cognitive Processes (3) I Intensive review of current theories and results in human cognitive processes from an information-processing perspective.

560a-560b. The Effects of Law on Psychology (3-3) 1986-87 Critical evaluation of the professional organizational standards and laws controlling the science and profession of psychology, and the clients of their services.

561a-561b. Theory and Research in Law and Psychology (3-3) [Rpt./1] 1985-86 Advanced topics in law psychology. 561a: Research and application. 561b: Methodology.

575. Personality Theory and Research (3) II Basic problems of theory construction, with application to theoretical systems in the personality area. P, 416.


577. Contemporary Issues in Clinical Psychology (3) [Rpt./1] II Advanced study of topical problem areas in clinical research and practice.

596. Seminar u. Interdisciplinary Environment-Behavior-Design (3) [Rpt./1] I (Identical with Idis. 596u, which is home)

600a-600b. Introduction to Graduate Training in Psychology (1-1) Basic areas of psyc., ethics and standards, teaching methods. Open to first-year psyc. grad. students only.

620. Clinical Psychopathology (3) I Advanced survey of symptoms, causes and treatments of the major psychological disorders. Current research and theory in psychopathology will also be considered. Open to majors only.
621. **Clinical Assessment Methods (3)** II Theory and practice in interview techniques and cognitive and personality assessment. Open to majors only.

622. **Clinical Principles of Behavior Modification (3)** I Systematic review of the major theories of behavior modification, with emphasis on application to clinical problems. Open to majors only.

623. **Clinical Insight Therapies (3)** II Theory, technique and research of approaches to behavior change which are oriented toward internal awareness, self-direction and personal responsibility by means of relationship, insight, and self-awareness. Open to majors only.

624. **Clinical Research Methods (3)** I Contemporary research issues in clinical psychology are critically examined. Open to majors only.

625. **Clinical Community Psychology (3)** II Expanding role of psychology in innovative mental health functions, with emphasis on consultation, program development, primary prevention and social system modification. Open to majors only.

626a-626b. **Clinical Group Psychotherapy (3-3)** 626a: Theory and practice of group psychotherapy. 626b: Experience in leading groups; advanced theory. 2R, 3L.

694. **Practicum**
   a. **Clinical Interviewing and Assessment (1 to 3) [ Rpt./1 ]** II Open to clinical psyc. students only.
   b. **Psychotherapy (1 to 3) [ Rpt./1 ]** II Open to clinical psyc. students only.
   c. **Community Mental Health (1 to 3) [ Rpt./1 ]** II Open to clinical psyc. students only.

**PUBLIC ADMINISTRATION**
(See Management and Policy)

**PUBLIC MANAGEMENT**
(See Management and Policy)

**PUBLIC POLICY, PLANNING AND ADMINISTRATION**
(See Management and Policy)

**RANGE MANAGEMENT**
(See Renewable Natural Resources)

**READING**

Professors Wilbur S. Ames, Elizabeth M. Antley, Amelia Melnik, Kenneth J. Smith, William J. Valmont

Associate Professors Adela A. Allen, Acting Head, Patricia L. Anders, John M. Bradley, Judy N. Mitchell

The department offers programs leading to the Master of Arts, Master of Education, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in reading. Concentrations are available which are designed to prepare special reading teachers, reading clinicians, reading consultants, classroom reading teachers, reading supervisors, college teachers, and researchers.

Applicants for the specialist and doctoral degree programs must submit scores on the aptitude test of the Graduate Record Examination, personal data blanks, and letters of reference to the Office of Graduate Studies in Education.

Master's degree programs are available for classroom reading teachers as well as for reading specialists, and include required units of course work in reading, a College of Education course requirement and electives for a total of 32 units. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational
Foundations and Administration Department to demonstrate equivalent preparation in research. A thesis is required for the Master of Arts degree. Requirements for the Educational Specialist degree include a written project. Doctoral degree programs are designed by the student and the adviser in consultation with the advisory committee. Doctoral candidates must complete Ed.P. 640. For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as result of the review.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title and Description</th>
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<tbody>
<tr>
<td>406.</td>
<td>Foundations of Reading Instruction in Spanish (2) GC II Introduction to the theoretical and practical aspects of the reading process, with attention to essential decoding and comprehension skills; special application for teaching Spanish-speaking children to read. Taught in Span. P, Span. fluency. (Identical with M.A.S. 406 )</td>
</tr>
<tr>
<td>435.</td>
<td>Secondary School Reading in the Classroom (3) GC I II Provisions and procedures for evaluating and developing reading skills needed in content areas. (Identical with S.Ed. 435 )</td>
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<tr>
<td>480.</td>
<td>Literature for Children (3) GC I (Identical with Li.S. 480 )</td>
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<tr>
<td>485.</td>
<td>Literature for Adolescents (3) GC I II (Identical with Li.S. 485 )</td>
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<tr>
<td>487.</td>
<td>Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487 )</td>
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<tr>
<td>488.</td>
<td>Microcomputer Application in Education (3')GC I S (Identical with Ed.F.A. 488 )</td>
</tr>
<tr>
<td>508.</td>
<td>Bilingual Reading (3) Analysis of reading situations encountered by bilingual students; phonological, semantic and syntactic aspects of instruction; methods and materials. (Identical with Ed.F.A. 508 and M.A.S. 508 )</td>
</tr>
<tr>
<td>510.</td>
<td>Computer Literacy for Teachers (3) I II S Microcomputer operation; software evaluation; use of author systems and word processors in the classroom; computer managed instruction; organization for computer use. P, Ed.F.A. 487.</td>
</tr>
<tr>
<td>561.</td>
<td>History of Children's Literature (3) II (Identical with Li.S. 561 )</td>
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<tr>
<td>571.</td>
<td>Classroom Diagnosis and Instruction (3) I II Procedures for diagnosing and developing reading skills for pupils of below-average achievement level. Open to nonmajors only.</td>
</tr>
<tr>
<td>602.</td>
<td>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.</td>
</tr>
<tr>
<td>605.</td>
<td>Essentials of Reading Instruction (3) I II Theories and principles underlying reading instruction, approaches to teaching reading, basic analysis of reading research.</td>
</tr>
<tr>
<td>607.</td>
<td>Analysis of Decoding (3) I II Phoneme theory; prerequisites for learning phoneme-grapheme associations; teaching word identification skills; examination and analysis of instructional materials and related research. P, 605 or CR.</td>
</tr>
<tr>
<td>612.</td>
<td>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, 605 or CR.</td>
</tr>
<tr>
<td>628.</td>
<td>Field Experience in Reading (3) I II Supervised experience in assessment and teaching of reading skills in the schools; use of developmental, corrective, and remedial techniques and practices.</td>
</tr>
<tr>
<td>633.</td>
<td>Psycholinguistics and Reading (3) I II Basics in psycholinguistics of reading and reading instruction, with emphasis on the comprehension of written language.</td>
</tr>
<tr>
<td>637.</td>
<td>Application of Miscue Analysis (3) II 1985-86 (Identical with Elem. 637 )</td>
</tr>
</tbody>
</table>
671. **Diagnostic Laboratory** (3 to 6) [Rpt./6 units] I II Supervised practice in reading assessment; identification of factors influencing reading achievement, evaluation, construction, and administration of assessment procedures; development of interview techniques. Open to majors only. P, 607, 612, 620 or CR.

672. **Instructional Laboratory** (3 to 6) [Rpt./6 units] I II Supervised practice in teaching reading; preparing, analyzing and critiquing special instructional programs for students. Open to majors only. P, 671 or CR.

680. **Investigations in Reading** (3) I II Analysis and synthesis of research in reading and its implications and influences on practice.

683. **Curriculum Development and Supervision in Reading** (3) I II Organizational patterns of reading curricula; approaches to the improvement of reading instruction; personnel relations. Designed for the reading supervisor and the school administrator. (Identical with Ed.F.A. 683)

686. **Classroom Reading: Issues, Concerns, Practices** (3) I II Critical analyses of principles, procedures and research related to the analysis, assessment, and improvement of reading abilities among individuals and groups at various levels.

695. **Colloquium**
   b. **Issues in Reading** (1 to 3) I II
   m. **Language, Learning and Reading Disabilities** (3) II (Identical with Spec. 695m, which is home.)

795. **Colloquium**
   a. **Problems in Reading** (1 to 3) I II [Rpt./15 units]

796. **Seminar**
   a. **Research and Evaluation** (1 to 3) I II [Rpt./15 units]

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**REAL ESTATE**

(See Finance and Real Estate)

**REGIONAL DEVELOPMENT**

(See Geography and Regional Development)

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**REHABILITATION**

Professors Amos Sales, *Head*, Bob G. Johnson
Associate Professors Marlene Bence, S. Mae Smith

The department offers programs leading to the Master of Science, Doctor of Education, and Doctor of Philosophy degrees with a major in rehabilitation. Concentrations are available in general rehabilitation counseling, counseling the deaf, counseling the substance abuser, vocational evaluation, and rehabilitation administration.

Admission requirements may be obtained by writing to the department. Deadlines for receipt of applications are as follows: (1) master's degree programs, May 1 for fall admission, and March 1 for summer admission; (2) doctor's degree programs, March 1 for fall admission, October 1 for spring admission, no summer admissions. Applicants for doctoral programs must submit scores on the aptitude test of the Graduate Record Examination. Master's degree students must submit either G.R.E. scores or a score on the Miller Analogies Test.

Students working toward the Master of Science degree are required to complete at least 54 units including twelve units of internship. With faculty approval, the number of required units may be reduced for students with substantial prior experience in rehabilitation. Each student will plan a program, with the assistance of an adviser, built around a core curriculum. Electives may be selected in the chosen area of concentration. All master's degree students must pass a comprehensive written examination and may be required, in
addition, to pass an oral examination. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. Doctoral candidates must complete Ed.p. 640. Specific requirements for doctoral programs may be obtained by writing to the department.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as a result of the review.

405. **Fundamental Sign Language** (3) GC I II Fundamentals of sign language to develop communication skills for providers of social services for the deaf.


419. **Behavior Principles for the Handicapped** (3) GC I II (Identical with Spec. 419)

420. **Advanced Conversational Sign Language** (3) GC I II Comprehensive study of basic sign language idioms and colloquialisms in Ameslan, with emphasis on continued skill building, expressive and receptive ability in Ameslan, and ability to converse with deaf adults. P, 410 or demonstrated proficiency.

425. **Advanced Ameslan** (3) GC I II American Sign Language, with emphasis on reverse, idioms, and grammatical structure. P, 420.

430. **Interpreting for Deaf People** (3) GC I II Principles, methods, and techniques of interpreting for deaf people in rehabilitation and other settings. P, 410 or demonstrated proficiency.

435. **Advanced Techniques of Interpreting** (3) GC I II Emphasis on rapid verbatim interpreting; educational, platform, and religious interpreting and the professional ethics involved; introduction to legal and medical interpreting. P, 430.

440. **Perspectives in Health Care Services** (3) GC II (Identical with Ph.Pr. 440)

450. **Interviewing and Client Services** (3) GC I II Intensive study of case procedures and techniques and their application to the functions of rehabilitation and related agencies, with emphasis on the case practices of interviewing. P, 300.

455. **Rehabilitation of the Aged** (3) GC II Emphasis on aging from the viewpoint of the aging person and those working with the aged.

470. **Disability and Relationships** (3) GC S Effects of disability on interpersonal relationships and ways to assist the disabled person with interpersonal difficulties.

480. **Problems of Drug Abuse** (3) GC [ Rpt./1] I 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.

485. **Rehabilitating the Public Offender** (3) GC I II Components in service delivery to the public offender, how the offender enters the criminal justice system, and treatment and rehabilitation services available.

487. **Microcomputers in Education** (3) GC I II S (Identical with Ed.F.A. 487)

488. **Microcomputer Application in Education** (3) GC I II S (Identical with Ed.F.A. 488)

500. **Principles of Rehabilitation** (3) I Principles underlying rehabilitation programs and interdisciplinary relationships of agencies engaged in rehabilitation services.

510. **Medical Aspects of Disability** (3) I II Etiology, therapy, and prognosis of the major disabilities, including drug and alcohol; assessment of physical capacities and limitations; typical restorative techniques.

520. **Psychosocial Aspects of Disability** (3) I II Exploration of the psychological and sociological aspects of disability; analysis of somatopsychology, psychosomatics, and social psychology.

550. **Principles and Practices of Vocational Evaluation** (3) I II Understanding work skills and labor market conditions; process of vocational evaluation of rehabilitation clientele; collecting and synthesizing evaluation data and writing meaningful reports.
557. **Methods in Marital Therapy (3)** I (Identical with C.D.F.R. 557)

560. **Role and Function of Workshop Facilities (3)** I II Defining the role and function of workshop facilities in rehabilitation; evaluation and production methods; wage and hour regulations; work adjustment methodologies.

600. **Counseling Practices in Rehabilitation Setting (3)** I II Facilitation training of rehabilitation professionals in their implementation of counseling practices with varied ethnic, age, disability, and dependency populations. 3R, 1L. Open to majors only.

620. **Client Assessment in Rehabilitation (3)** I II Exploration of the world of work; critical review of vocational choice theories; experiences in the use and interpretation of individual assessment techniques. P, Rhab. 500 or CR.

630. **Vocational Planning and Placement (3)** I 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, 500, 620.

640. **Psychosocial Assessment of the Deaf Person (3)** I II Selection, administration, and interpretation of various psychosocial evaluation instruments used with deaf persons. P, Ed.P. 671, 672a.

650. **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.


695. **Colloquium**
   a. Rehabilitation Psychology (3) I II Identification and analysis of current problems in rehabilitation.
   b. Rehabilitation Administration (3) I II
   c. Vocational Evaluation (3) I II
   d. Rehabilitation of the Deaf (3) I II
   e. Group Processes (3) I II

730. **Investigations in Rehabilitation Psychology (3)** I II Identification and analysis of current problems in rehabilitation.

796. **Seminar**
   a. Assessment in Rehabilitation Psychology (3) I II P, 500, 620; Ed.P. 672b.
   b. Current Issues in Rehabilitation Psychology (3) Open to majors only. P, 500, 620; Ed.P. 692.

**REMOTE SENSING**

**Committee on Remote Sensing**

Professors Philip N. Slater (Optical Sciences), Chairperson, Victor R. Baker (Geosciences), Dinshaw N. Contractor (Civil Engineering), Benjamin N. Herman (Atmospheric Sciences), Donald F. Post (Soils, Water and Engineering), John A. Reagan (Electrical and Computer Engineering), Richard W. Reeves (Geography and Regional Development)

Associate Professors Charles E. Glass (Mining and Geological Engineering), Robert A. Schowengerdt (Electrical and Computer Engineering; Arid Lands Resource Sciences)

Assistant Professors Alfredo R. Huete (Soils, Water and Engineering), Charles F. Hutchinson (Arid Lands Resource Sciences), John W. Olsen (Anthropology), William O. Rasmussen (Renewable Natural Resources)

Remote sensing concerns the collection of information related in some way to the earth's natural resources or environment. Data are primarily collected by satellite and aircraft systems in conjunction with localized ground-based surveys and measurements. The data are processed by digital computer or optical techniques to extract information of value to earth scientists and resource and environment managers at the local, state, and federal levels.
The Committee on Remote Sensing offers no graduate major at the present time but minor programs are available for doctoral students with majors in disciplines within the Colleges of Agriculture, Business and Public Administration, Engineering, Arts and Sciences, and Mines; and in the Office of Arid Lands Studies and the Optical Sciences Center. Emphases are available in applied remote sensing or in remote sensing techniques.

Students electing the emphasis in applied remote sensing are required to complete at least twelve graduate units or Geog. 330 (without graduate credit and described in the General Catalog only) and ten graduate units. The program must include Opti. 550 and E.C.E. 531 and either Geog. 330, G.En. 407 or Ws.M. 420. The remaining units may be selected from Ws.M. 422, Agri. 453, C.E. 454, Geog. 483, or G.En. 507.

Students electing the emphasis in techniques of remote sensing must complete twelve graduate units including Opti. 550 and E.C.E. 531. The remaining units may be selected from Opti. 524, 539, 552, 558, 559, 567; Atmo. 561, 656a-656b, 683.

Students are urged to discuss the program with members of the Committee on Remote Sensing before selecting the courses to be taken. The program selected must be approved in advance by the Committee.

The School of Renewable Natural Resources offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in watershed management, range management, wildlife and fisheries science, and renewable natural resources studies. The school also offers a program leading to the Master of Landscape Architecture degree. For information concerning this degree see Requirements for Master's Degrees/Master of Landscape Architecture elsewhere in this catalog.

Applicants for the Master of Science and the Doctor of Philosophy degree programs are required to submit three letters of recommendation and scores on the Graduate Record Examination. For information concerning the doctor's degree, see Requirements for Doctor's Degrees/Doctor of Philosophy elsewhere in this catalog.

Graduate programs are individually planned after consideration of the student's preparation, area of interest, and career objectives. The purpose of the programs is to train people (1) for research and teaching in the area of natural resource management and planning, and (2) for land management positions requiring specialization in 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 climate.

Majors

WATERSHED MANAGEMENT or RANGE MANAGEMENT — Concentrations are available in watershed hydrology, natural resource recreation, forest management, dryland forestry, and range science. Applicants should normally have completed an undergraduate major in watershed management, 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 a minimum of sixteen units in established watershed management, range management, or natural resource recreation courses.

Students working toward the Master of Science degree may select either of two plans: (1) complete at least thirty units including a thesis for which as many as five units may be earned, or (2) complete at least 36 units including an acceptable professional paper for which as many as three units may be earned.

WILDLIFE AND FISHERIES SCIENCE — This major includes specializations in wildlife ecology and fisheries science. Both programs require the completion of at least 30 units including a minimum of fifteen units of coursework and an acceptable thesis focusing on original research that addresses a wildlife and fisheries management topic, for the master’s degree. With the approval of the student’s advisory committee, students may elect to use the professional paper option which requires at least 36 units including a minimum of 30 units of coursework plus preparation of an acceptable professional paper for which six units of credit may be earned.

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 area. The master’s degree requires at least 36 units including a thesis or professional paper for which six units may be earned.

Renewable Natural Resources

477. Economics of Water and Land Resources (3) GC I (Identical with A.Ec. 477)

546. Principles of Research (3) I Philosophy of science and research, the scientific method, problem selection, problem analysis, study plans, scientific communications. Klemmedson

595. Colloquium
   a. International Renewable Resource Issues (2) I 1986-87
   b. Public Natural Resource Management (2) II 1986-87
   c. Human Dimensions in Renewable Natural Resources (2) I 1985-86
   d. Topics in Forest and Range Ecology (2) II 1985-86

597. Workshop
   a. Natural Resource Conservation Workshop (1) [ Rpt./2] II S Field trips.

696. Seminar
   a. Renewable Natural Resources (1 to 2) [ Rpt.] II 1985-86.

Landscape Resources

Ervin H. Zube, Chairperson of the Division

Landscape Architecture

410. Site Planning and Design (5) GC I Problems in urban and rural environments; site planning and design principles and issues. 2R, 9L. P. 111

411. Urban Landscape Planning and Design (5) GC II Planning and design problems in urban environments. 2R, 9L. P. 410.

412. Urban/Rural Landscape Planning and Design (5) GC I Planning and design problems at the urban/rural interface; issues of growth and change. 2R, 9L. P. 411.

413. Regional Landscape Planning and Design (5) GC II Planning and design problems of regional scope and emphasis. 2R, 9L. P. 412.
RENEWABLE NATURAL RESOURCES

414. Internship Preparation (1) GC II Orientation and proposal development for off-campus project. P, 412


428. Field Methods in Environmental Psychology (3) GC II (Identical with Psyc. 428)

435. Planting Design (3) GC II Application of plant materials to problems in landscape design. 2R, 3L. Field trips. P, 111, 334a or 334b.

441. History and Theory of Landscape Architecture (3) GC II Examination of the historical background and theoretical basis of landscape architecture. P, 410.

450. Landform, Grading and Drainage (3) GC I Introduction to topography, contour, grading, and drainage. 2R, 3L. Field trips. P, 111, 250.

451. Site Engineering (3) GC II Grading, road layout, utilities, and other site engineering considerations. 2R, 3L. Field trips. P, 450.

452. Landscape Construction (3) GC I Construction materials and methods in landscape architecture; introduction to working drawings and specifications. 2R, 3L. P, 451.

453. Professional Practice (3) GC II Professional services, contract documents, contract administration, office organization, ethics, professional registration, roles of the landscape architect, the practice of landscape architecture. P, 415.

497. Workshop
   I. Community Design for Non-Designers (3) GC I (Identical with Arch. 497i, which is home)

533. Critical/Significant Environments (3) I Assessment and management of natural and cultural critical environmental resources, including natural, scenic and historic areas, habitats of rare and endangered species, and unique resource combinations. 2R, 3L. Field trips.

595. Colloquium
   a. Systems Ecology for Planners and Designers (3) I
   b. Western Wildland Planning and Design (3) I

596. Seminar (3) I
   u. Interdisciplinary Environment-Behavior-Design (Identical with Idis. 596u, which is home)

696. Seminar (1 to 3) II
   a. Landscape Architecture (1) [ Rpt.]

Range Resources

E. Lamar Smith, Chairperson of the Division

Range Management


446. Range Improvements (3) GC I Range improvements through grazing systems, noxious plant control, cultural and mechanical elements of revegetation, runoff control, and specialized range and critical area treatments. 2R, 3L. Weekend field trips. P, 305, Ecol. 102.

456. Range Evaluation (3) GC II Methods of evaluating range vegetation, productivity, carrying capacity, utilization, condition and trend; measurement techniques and interpretation of data. 2R, 3L. P, 305, 382, 416, R.N.R. 321.

480. Forest Policy and Administration (3) GC II (Identical with Ws.M. 480)

486. Range Planning and Economics (3) GC I Principles of management planning for rangelands and economic analysis of management alternatives; includes case studies, linear programming, computer simulation. P, 305; A.Ec. 215 or 476 or Ws.M. 440.

487. Ranch Planning (2) GC II Preparation of a range management plan for a ranch enterprise including field data collection, economic and environmental analysis of management alternatives. 8L. All-day field trips. P, CR 456; 486.
595. Colloquium
   a. Rangeland Policy (2) I 1986-87
   c. Range Herbivores (2) I 1985-86

696. Seminar
   a. Range Management (1) [ Rpt.] I II

Forest-Watershed Resources

Gordon S. Lehman, Chairperson of the Division

Watershed Management

408. Forest Fire Management (3) GC I Forest fire behavior, as influenced by fuels, weather, topography; ecological effects of fire; prevention, detection and control methods; fire danger rating and use of prescribed fire in forest management. Zwolinski

410. Silviculture (3) GC II Principles and technical procedures for reproducing, planting, and tending forest crops, with reference to watershed. P, 342 or Ra.M. 382; Ecol. 102.


420. Photogrammetry (2) GC I 1986-87 Aerial photographic planning for natural resource management; stereoscopic principles applied to planimetric and topographic mapping. 1R, 3L; P, Math. 116.

422. Photointerpretation (2) GC II Reading and interpretation of aerial photographs; natural resource inventory from aerial photographs; remote sensing techniques. 1R, 3L. Lehman

425. Wood Products (2) GC II 1986-87 Harvesting, processing, and marketing of wood products. P, Ecol. 104 or Pl.S. 100. Ffolliott

427. Bioclimatology (3) GC II (Identical with Atmo. 427)

430. Forest Resource Management (3) GC I Decision making in the management of forest lands. 2R, 3L. P, 410, 415, 440.

440. Forest Resource Economics (3) GC II Economics of the production of goods and services from forest lands; decision making in microforest resource management situations; supply and demand relationships for products of forest resources. P, Econ. 201a, 201b, Math. 123. (Identical with A.Ec. 440) King

459. Rangeland Water Management (3) GC II Hydrologic principles as applied to arid and semiarid ecosystems with water management applications in range management, wildlife, fisheries and recreation. Credit is allowed for this course or 462, but not for both. P, Math. 160 or 263 and S.W.201.

460. Watershed Hydrology (3) GC I Application of fundamental principles to quantifying the basic hydrologic processes occurring on watersheds. P, Geos. 100a; S.W. 200, 201, Math. 160. (Identical with Hydr. 460) Gay

462. Watershed Management (3) GC II Evaluating hydrologic impacts of management activities on watersheds to include silviculture, range, mining, and recreation use.

464a-464b. Introduction to Dendrochronology (3-3) GC (Identical with Geos. 464a-464b)

471. Water Quality Control (3) GC II (Identical with C.E. 471)

476. Natural Resource Economics (3) GC II (Identical with A.Ec. 476)


481. Simulation of Renewable Natural Resources (3) GC II Simulation of management impacts for multi-resource decision-making, including biologic, economic, and social factors. 2R, 3L. P, 430.
487. Forestry in Arid Environments (4) GC S Management and development of wood and other forest resources in developing nations. Designed for mid-level and upper-level resource professionals from developing nations. Field trip.

488. Development and Management of Water Resources (6) GC S Development and management of water resources on forest watersheds and rangelands in developing nations. Designed for mid-level and upper-level resource professionals from developing nations. Field trip.


531. Dryland Forestry (2) II 1986-87 Utilization and management of forest resources in dry environments; biophysical and socio-economic issues related to the development of forest commodities and amenities. P, 342.

532. Agroforestry (2) I 1985-86 Ecological and socioeconomic factors related to the planning and implementation of agroforestry systems. P, 531.


557. Quantitative Dendrochronology (3) I 1986-87 (Identical with Geos. 557)

563. Plant-Water Relations (3) II (Identical with M.C.B. 563)

565. Hydrochemistry (3) II 1985-86 (Identical with S.W. 565)

566. Botanical Basis of Dendrochronology (3) II 1985-86 (Identical with Geos. 566)

585a-576b. Advanced Natural Resource Economics (3-3) (Identical with A.Ec. 576a-576b)

663. Colloquium a. Non-Point Source Pollution from Watersheds (3) II P, 460.

655. Colloquium a. Watershed Management (1) [Rpt.] II

Wildlife, Fisheries and Recreation Resources

William W. Shaw, Chairperson of the Division

401. Aquatic Entomology (3) GC II 1986-87 (Identical with Ento. 401)

430. Principles of Nutrition (3) GC I II (Identical with An.S. 430)

441. Limnology (4) GC I Study of lakes and streams; biological characteristics as related to physical, chemical, geological, and historical processes operating on fresh waters. 2R, 6L. Weekend field trips. P, six units of chem. or phys. with lab. (Identical with Ecol. 441) Matter

444. Wildlife Management (4) GC I Management of wildlife as a resource; characteristics of wildlife species; principles of population dynamics in wildlife populations. 3R, 3L and field work. Weekend field trips. P, 125, Ecol. 104; 102 or Ra.M. 416. Krausman

446. Wildlife Management Techniques (4) GC II Field and lab. methods used in wildlife management; evaluation of wildlife habits; census, productivity, diagnosis, and control of wildlife populations. 2R, 6L and field work. Weekend field trips. P, 444.

448. Current Problems in Wildlife Ecology (1) GC [Rpt.] I Discussions and assignments covering current problems, including the biological, economic, aesthetic, political, and sociological phases of wildlife management. P, 444 or 446. Sowls

455R. Fishery Management (3) GC II Methods and concepts pertaining to fishery investigations and management; application of principles for production of optimum fisheries to benefit man. P, 441 or 444. Matter
300 DEPARTMENTS AND COURSES OF INSTRUCTION

455L. Fishery Management Laboratory (1) GC II Laboratory methods pertaining to fishery investigations and management. P, CR 455R, 482. Matter

482. Ichthyology (4) GC I (Identical with Ecol. 482)

484. Ornithology (4) GC II (Identical with Ecol. 484)

485. Mammalogy (4) GC I (Identical with Ecol. 485)

584. Selected Studies of Birds (2) II (Identical with Ecol. 584)

595. Colloquium
   a. Big Game Management (2) I 1986-87 P, 444.
   c. Wildlife Habitat Analysis (2) II 1985-86.

630. Issues in Fishery Science (2) [ Rpt. ] II Procedures for critical evaluation of diverse fishery and aquatic science topics. Tash/Ziebell

649. Fishery-Water Quality Relationships (2) I Pertinent water quality parameters essential for fish life, and the effects of various substances and their interrelationships to fish and aquatic organisms. P, 441 or 455R; Chem. 241a. Ziebell

696. Seminar (1 to 3) I
   a. Fish and Wildlife Ecology (1) [ Rpt. ]

Natural Resource Recreation


470. Economics of Outdoor Recreation (3) GC II 1985-86 Application of economic tools to recreation planning and management, including recreation demand and supply, recreation use projection methods, recreation resource valuation and policy issues. P, Econ. 201b or A.Ec. 204; Math. 160. (Identical with A.Ec. 470) King

475. Recreational Behavior (2) GC II 1985-86 Theories of leisure behavior and their implications for management of natural resources for outdoor recreation. P, 381, 388.

595. Colloquium

ROMANCE LANGUAGES

Committee on Romance Languages (Graduate)

Professors Robert ter Horst (Spanish and Portuguese), Dana A. Nelson (Spanish and Portuguese)

Associate Professors Ingeborg Kohn (French and Italian), Henri Servin (French and Italian)

The Committee offers a Master of Arts degree with a major in Romance languages. Administered by the Department of French and Italian and the Department of Spanish and Portuguese, it is primarily intended for future high-school or junior-college teachers and enables graduate students to acquire a sound foundation in fundamental aspects of two Romance languages. The degree requires 39 units of coursework in two of the following languages: French, Italian, Portuguese, and Spanish (21 units in one language and 18 in the other). For further information, please inquire in either department.

422. Introduction to Romance Philology (3) GC I 1986-1987 (Identical with Span. 422)

429. Pedagogical Linguistics: Applied Linguistics for Teachers (3) GC II (Identical with Or.S. 429)

RUSSIAN AND SLAVIC LANGUAGES

Professors John Garrard, Head, Joe Malik, Jr.

Associate Professors Alexander Dunkel, Margaret Gibson, Boriss Roberts

Assistant Professor Adele Barker
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 cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major 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, 24 of which must be in Russian, including 581, either 583 or 685, and two seminars. All graduate teaching assistants must take 579. With the permission of the head of the department, the remaining units must be selected from appropriate supporting courses in other disciplines. 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. Prior to taking the final examination, each student must give satisfactory evidence of proficiency in the use of the Russian language or of the English language if applicable.

405a-405b. Survey of Russian Literature (3-3) GC Historical survey of Russian literature from the earliest times to the Soviet period; designed to acquaint students with literary terminology and facilitate comprehension of lectures in Russ. Advanced degree credit available only with departmental permission. P, 301b or 305b.

501a-501b. Russian Stylistics (3-3) Designed to improve the student's practical mastery and understanding of Russ. at a higher and more sophisticated level. P, 301b.


579. Problems of Teaching Russian (3) I Survey of modern methods of language teaching, with emphasis on the particular problems presented by Russ. 405b.

581. Russian Phonology and Morphology (3) II P, 301b or 305b.

583. History of the Russian Language (3) I P, 301b or 305b.


685. Old Church Slavic (3) A study of Old Church Slavic language and its relationship to Old Russian and Modern Russian. P, 301b or 305b.

686. Russian Drama (3) II 1986-87 Examination of the major dramatic works of nineteenth- and twentieth century Russian playwrights. P, 405b.

696. Seminar
   a. Slavic Philology (3)
   b. Russian Literature: 18th Century (3)
   c. Russian Literature: 19th Century (3)
   d. Russian Literature: 20th Century (3)
   e. West Slavic Literature (3)

SECONDARY EDUCATION

Professors Robert J. Letson, Head, Paul M. Allen, William D. Barnes, Donald C. Clark, Emil S. Gavlak (Emeritus), Raymond L. Klein (Emeritus), Richard C. Krebs (Emeritus), Howard W. Leigh (Emeritus), Mark C. Smith, Arthur H. Steinbrenner (Emeritus) Associate Professors Margaret B. Fleming, Bruce R. Ledford, Glenn S. Pate, James R. Rankin, D. Paul Robinson
Assistant Professors George Babich, Jacqueline J. McMahon, Janice L. Streitmatter
The department offers programs leading to the Master of Arts, Master of Education, Master of Teaching, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in secondary education and programs leading to the Master of Education and Educational Specialist degrees with a major in educational media. The department also offers programs leading to the Master of Education degree with a variety of majors relevant to secondary school teaching. For information concerning these degree programs see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Applicants must have completed a bachelor's degree including at least fifteen units in education, except that this requirement may be waived or modified for applicants in educational media who have other appropriate backgrounds. Applicants for specialist or doctoral programs must submit scores on the aptitude and advanced tests of the Graduate Record Examination, a personal data blank, and letters of reference to the Office of Graduate Studies in Education. Graduate programs are individually planned to fulfill the professional objectives of the student. Degree programs may also draw upon course work in the arts and sciences or in other areas of education. A thesis is required for the Master of Arts degree. All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. Doctoral candidates must complete Ed.P. 640. For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major advisor to assure that they understand any changes which may have been made as result of the review.

403. Study of Exceptional Children (3) GC I II (Identical with Spec. 403)
405. Mathematics in the Secondary School (3) GC II Study and analysis of curriculum changes in school mathematics, with emphasis on the design and content of experimental programs such as SSMCIS. P, three units of ed.; Math. 125b. (Identical with Math. 405)
408. English as a Second Language in Bilingual Education (3) GC I II (Identical with Engl. 408)
410. Teaching English Composition (3) GC I II (Identical with Engl. 410)
411. Teaching of Literature (3) GC I II (Identical with Engl. 411)
412. The Teaching of the English Language (3) GC I II (Identical with Engl. 412)
414. Teaching of Modern Languages (3) GC II Specific methods, objectives, organization of subject matter and evaluation in modern languages. (Identical with Fren. 414 and Span. 414)
417. Media in Instruction (3) GC I II S Basic design and production of media for instruction; selection and integration of materials; equipment operation. (Identical with Elem. 417 and Li.S. 417)
418. Educational Photographic Media (3) GC I Basic photographic techniques, as applied to the teaching process; still and motion picture photography; individual training in filming, developing and editing. Field trip.
427. Bilingual/Bicultural Education Curriculum Development (3) GC II (Identical with Ed.F.A. 427)
429. Pedagogical Linguistics: Applied Linguistics for Language Teachers (3) GC II (Identical with Or.S. 429)
435. Secondary School Reading in the Classroom (3) GC I II (Identical with Rdng. 435)
441. Instructional Systems Curriculum Development (3) GC I II S Basic skills and knowledge required for curriculum developers to analyze, design, construct and evaluate instructional programs.
442. Implementing Systems Instruction (3) GC I II S Management and evaluation of systems instructional environment; concentration on management styles and internal and external evaluations.
443. Advanced Instructional Methods (3) GC I II S Theory and application of instructional methodologies; development and implementation of units of instruction using the methodologies studied.
Classroom Management for Training (3) GC I II S Strategies and objectives used in managing the learning environment, controlling student problems, and implementing due process procedures.

Techniques of Teaching Adults (3) GC II Techniques and issues of adult learning and the dynamics of the teaching and learning processes.

Teaching Vocational Office and Distributive Education (3) GC II (Identical with B.C.Ed. 482)

Development and Instruction of Adult Vocational Education Programs (3) GC I (Identical with B.C.Ed. 483)

Organization and Supervision of Vocational Education Programs (3) GC I (Identical with B.C.Ed. 484)

Cooperative Vocational Education Programs (3) GC II (Identical with B.C.Ed. 485)

Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487)

Microcomputer Application in Education (3) GC I II S (Identical with Ed.F.A. 488)

Methods and Materials in Bilingual Education (3) I II (Identical with Elem. 526)

Career Education (3) I (Identical with Coun. 531)

The Middle School/Junior High (3) II History, purposes, curriculum, and administration of the middle school/junior high.

Law for Teachers and Student Personnel Workers (3) I (Identical with Ed.F.A. 567)

Colloquium

c. Language Experiences in Learning (3) II S (Identical with Elem. 595c, which is home)

Workshop

b. Educational Film and Video in the Classroom (3) I
e. Newspaper in the Classroom (1 to 3) I II S (Identical with Elem. 597e, which is home)
f. Investigating the Environment (1 to 3) I II S (Identical with Elem. 597f)
o. Teaching of English (3) I II S (Identical with Engl. 597o, which is home)
r. Curriculum for Self Development (3) S (Identical with Elem. 597r)
w. Southern Arizona Writing Project (3 to 9) [Rpt./12 units] I II S (Identical with Elem. 597w and Engl. 597w)

English Grammar for ESL (3) I (Identical with Engl. 612)

Teaching of ESL (3) I (Identical with Engl. 613)

Coordination of Instructional Media Programs (3) I Study of organization and distribution practices of media utilization; budgeting, public relations, and implementation of media preparation and media-service programs. P. 417. (Identical with Elem. 616 and Li.S. 616)

Preparation of Instructional Materials (3) I Study of techniques used in the development of instructional materials and processes. P. 417. (Identical with Elem. 617 and Li.S. 617)

Research Trends in Instructional Technology (3) I Past and current trends in instructional technology.


Classroom Communication and Interaction (3) II The teacher's role in promoting effective communication and interaction in the classroom situation.

Curricular Studies in School Mathematics (3) II 1986-87 Experimental programs in school mathematics, with emphasis on selection of content and on problems in design and evaluation. (Identical with Elem. 631)

Student Activities and Government (3) I Philosophy, values, and coordination of school activities in the secondary school, with emphasis on the theory, organization, and supervision of student government and interscholastic athletics.

Analysis of Secondary School Teaching (3) I Analysis of the teaching process; preparation of behavioral objectives; study of recent methods, trends; analysis of current classroom evaluation techniques.
635. Organization and Functions of the Secondary School (3) I Secondary school: its organization, structure and operation; role and responsibilities of the teacher, the administrator and other personnel.

636. Innovations in Secondary Education (3) II Change process in education, with emphasis on those elements which support or hinder change in the schools; detailed study of current secondary school innovations on the national and local levels.

638. Constructing the Secondary School Curriculum (3) I Curriculum and its relationships; basic theories and techniques of curriculum construction discussed, evaluated, and applied.

639. Investigations in Secondary Education (3) I Critical study and evaluation of the investigations and experimental evidence underlying the aims and instructional practices of the various subject-matter fields of the secondary school.

640. Human Relations in the Classroom (3) II Analysis of human behavior in the classroom, with emphasis on case studies, role playing and group dynamics.

647. The Principalship (3) I S (Identical with Ed.F.A. 647)

648. The Superintendency (3) II S (Identical with Ed.F.A. 648)

695. Colloquium
b. Secondary School Scope and Function (1 to 3) I II P, 635.
c. Issues in Secondary Education (1 to 3) I II P, 635.
d. Secondary School Curriculum (1 to 3) I II P, 638.
e. Secondary School Instruction (1 to 3) I II P, 638.
g. Master's Colloquium in Secondary Education (1 to 3) I II

697. Workshop
a. Evaluating the Secondary School (1 to 3) [ Rpt./2] I II
b. Teacher Self-Appraisal (1 to 3) I II (Identical with Elem. 697b)
c. Classroom Teaching Innovations (1 to 3) I II
d. Democratic Processes in the Classroom (1 to 3) I II
e. Personalization and Individualization of Instruction (1 to 3) I II
f. Simulation and Gaming in the Classroom (1 to 3) I II (Identical with Elem. 697f)
g. Values Education in the Classroom (1 to 3) I II
h. Educational Implications of Prejudice (1 to 3) I II
i. Equality in Education (3) II S
j. Teacher Style and Student Achievement (3) S
k. Problems and Processes in Teacher Appraisal (1 to 3) [ Rpt./6 units] I II (Identical with Ed.F.A. 697n and Elem. 697n)
l. Creating Classroom Alternatives (3) II (Identical with Elem. 697s)

794. Practicum
b. Bilingual Education (3) [ Rpt./2] I (Identical with Ed.F.A. 794b, which is home.)

796. Seminar
a. Secondary Education (1) [ Rpt./6] I II

SOCIOLOGY

Professors Richard F. Curtis, Head, Raymond V. Bowers (Emeritus), Maynard L. Erickson, Andrew M. Greeley, Robert L. Hamblin, Michael Hechter, Travis W. Hirschi, Gary F. Jensen, Robert C. Leonard, I. Roger Yoshino

Associate Professors Albert J. Bergesen, James T. Borhek, Courtney B. Cleland, Robert R. Evans, Celestino Fernandez, Neil D. Fligstein, Patricia L. MacCorquodale, Jerry L. L. Miller

Assistant Professors Roberto M. Fernandez, Debra Friedman, Joseph R. Hamben (Emeritus), Douglas J. McAdam, Trudy L. Mills, Michael E. Sobel

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in sociology. A concentration in applied sociology is available at the master's level. A brochure describing these programs is available from the department on request.
Potential applicants are urged to include strong courses in theory, methodology, and statistics in the undergraduate program. Applicants must submit scores on the aptitude test of the Graduate Record Examination and two letters of recommendation. The undergraduate record must show an average grade of "B" or higher in sociology and in all work completed during the last two years of college study. The average grade for all undergraduate work must be at least "B-" and, unless the student has a very strong undergraduate record, the student's scores on the Graduate Record Examination, both quantitative and verbal portions, must be very high. Applications must be received by January 15 if financial assistance for the following semester is desired.

Degrees

MASTER OF ARTS — For the master's degree, thirty units of credit for 500-level courses (those open to graduate students only), excluding independent study and including the following courses: 500a-500b, 570a-570b, 575; and three to six units of research seminar. For students who terminate their work at this institution with an M.A. degree, two research papers prepared for 500-level courses must be submitted. For students who continue toward the Ph.D. at this institution, a data-analysis paper must be submitted. Both require a final oral examination. There is no language requirement for the M.A. The M.A. with an emphasis on applied research is a vocationally oriented program which involves training in the techniques of applied social research and the chance to use these techniques in practical field experience. M.A. students emphasizing applied social research take one less theory course, and they are required to complete a data-analysis paper reporting the findings of an applied research project. This specialty will not generally lead to admission to the Ph.D. program.

DOCTOR OF PHILOSOPHY — For the Ph.D., a minimum of 69 units of course work, including eighteen units of dissertation and the minor, are required. All students are required to complete the statistics, methods, theory, and research seminar requirements set forth above for the M.A. In addition, students are expected to complete two of the following courses: 505, 510, 525, 530, 541 or 550 and two of the following: 521, 522, 560, 578, 580, 596. Written preliminary examinations must be completed in two major areas and one minor area (culture, deviance and control, population and ecology, social interaction and socialization, social organization, and social stratification). If the minor is taken within the Department of Sociology, the student must write preliminary examinations in three of these areas. An oral preliminary examination must be taken when the written exams have been passed. The Ph.D. at this institution requires proficiency in any one of the following: a foreign language, mathematics, or computer science. Dissertations will generally be contributions to knowledge through original, empirical research.

402. Kinship and Social Organization (3) GC I (Identical with Anth. 402)

404. Sociology of the Southwest (3) GC I Populations, cultures, and social problems in their regional setting, with emphasis on the Southwest. P, 100 or 301; six additional units of soc. or anth. (Identical with Anth. 404, A.In.S. 404 and M.A.S. 404)


407. Peasant Communities (3) GC I (Identical with Anth. 407)

422. Complex Organizations (3) GC II Theories and research regarding large-scale organizations and their relations to the individual and society. P, nine units of soc.*

435. Public Opinion and Voting Behavior (3) GC II (Identical with Pol. 435)

436. Social Structure and Personality (3) GC II Relation between the person and the group; social factors in character formation. P, nine units of soc.

442. Transformation of Agrarian Societies in the Middle East (3) GC II (Identical with Or.S. 442)

444. Group-Process Methods in Public Administration (3) GC II Open only to students who meet the requirements for Advanced Standing as specified in the College of Business and Public Administration section of the catalog. (Identical with M.A.P. 444)
450. Social Stratification (3) GC I II Theories of social class, caste, and rank; social mobility in contemporary society. P, nine units of soc.* (Identical with Anth. 450)

*A major in another social science may be substituted for three of these units.

457. Bio-Social Determinants of Socialization (3) GC II (Identical with C.D.F.R. 457)

459. Sociology of Male and Female Roles (3) GC II Social factors in sex-role identification and the perpetuation of sex roles; consequences for individuals and for society; emphasis on research. P, nine units of soc. (Identical with W.S. 459)

461. Race and Ethnic Relations (3) GC I II Social processes involved in minority groups in terms of race, caste, class, ethnicity, politics, and religion. P, 100 or 301; six additional units of soc. or anth. (Identical with Anth. 461, A.In.S. 461, BI.S. 461 and M.A.S. 461)

468. Comparative Community Development (3) GC I Principles of social change applied to problems of community development, including analysis of specific programs. P, six units of soc. sci. (Identical with Anth. 486)


505. World-System Theory and Research (3) I II Theory and research on the modern world-system.

510. Political Sociology (3) Basic approaches in political sociology, with emphasis on the relationship of economic and political processes.

522. Advanced Sociology of Religion (3) Review of the classical literature in the sociology of religion, including critical reading of recent research.

525. Intermediate Complex Organizations (3) Basic review of classic and contemporary approaches to the study of complex organizations; formation, development, and internal processes. (Identical with M.A.P. 525)

530. Graduate Social Psychology (3) Basic study of classic and contemporary approaches with particular reference to socialization and the relationship between the individual and social structure.

541. Deviance and Social Control (3) Basic critical review of traditional and contemporary concepts and formulations of deviance and social control; evaluation of contemporary research bearing upon deviance theory and informal and formal mechanisms of social control. P, 201, 341 or 342.

550. Stratification and Class (3) Basic examination of concepts and research in the area of stratification, with emphasis on the classic statements and contemporary research.

560. Intergroup Relations (3) Analysis of recent research on the relations among racial and ethnic groups in society, with special attention to current empirical and theoretical issues. P, 461.

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.)


580. Population Studies (3) I 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.

585. Advanced Sociological Theory (3) I Sociological theories as alternative explanations. Classic and modern examples of working through the implications of alternative theories to formulate competing hypotheses for empirical tests. P, two courses in Social Science theory, preferably 500a-500b.

595. Colloquium
   a. Introduction to Graduate Study (1) I

596. Seminar
   a. Advanced Problems in Research (1 to 3) [Rpt.] I II
   c. Advanced Problems in Deviant Behavior (1 to 3) I II
   d. Selected Problems in Sociological Statistics (1 to 3) I II
   f. Advanced Social Change (1 to 3) [Rpt.] I II
   g. Advanced Juvenile Delinquency (1 to 3) I II
   h. Macrosociology (1 to 3) I II
SOIL AND WATER SCIENCE
(See Soils, Water, and Engineering)

SOILS, WATER, AND ENGINEERING


Associate Professors M. D. Cannon (Emeritus), Wayne E. Coates, David M. Hendricks, Dennis L. Larson, Ian L. Pepper

Assistant Professors Alfredo Huete, Allan D. Matthias, Muluneh Yitayew

Soils, water and engineering includes chemistry, physics and engineering applied to management of soil, water, air, energy and human resources in environments for plant and animal growth in both production agriculture and natural and urban situations.

Graduate degree programs in agricultural engineering, irrigation, and soil and water science are described in the sections following.

Agricultural Engineering

The department offers programs leading to the Master of Science degree with major in agricultural engineering.

Concentrations for agricultural engineering majors are available in irrigation; water resources; mechanization of field and vegetable crop production; environmental control and materials handling in livestock, dairy, and poultry production; agricultural systems analysis; and agricultural energy systems.

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.

406. Applied Hydraulics (3) GC I Fundamentals of hydraulics applicable to the irrigation of agricultural lands, including fluid properties, hydrostatics, irrigation flow characteristics, open channel and pipeline applications, and measurement of flowing water. P, 118, 123 or 125a, Phys. 102a.


425. Agricultural Engineering Design (3) GC I Selected design problems in the fields of agricultural machinery, buildings, and irrigation. 1R, 6L. P, six units of agricultural engineering courses at the 400-level. Larson

450. Irrigation Principles and Management (2) GC I Principles of operating farm irrigation systems, evaluation of systems, selection of systems, basic drainage, principles, energy management, basic irrigation scheduling. P, 250 or a water related course, Math. 117e, S.W. 200; CR 451.

308 DEPARTMENTS AND COURSES OF INSTRUCTION

455. Surface Irrigation (3) GC II Design and operation of border, basin, furrow, and return flow systems, basic drainage design. 2R, 3L. Field trip. P, C.E. 321. (Identical with C.E. 455 )


463. Energy from Biomass (3) GC II Biomass energy sources; collection and processing methods; thermal, anaerobic digestion and fermentation, conversion, energetics, economic and environmental issues. 2R, 3L. P, A.M.E. 340a. (Identical with N.E.E. 463 ) Larson

507. Drainage of Irrigated Lands (3) II Origin and nature of drainage problems in arid lands; drainage theories, investigations and design for irrigated agriculture and land reclamation. Field trip. P, 406 or S.W. 470. (Identical with C.E. 507 )


595. Colloquium a. Current Subjects in Soil Science and Agricultural Engineering (1) [ Rpt./3] I II. (Identical with S.W. 595a which is home)

650. Advanced Irrigation Management (3) II 1985-86 Irrigation scheduling using Jensen-Haise and Penman equations for predicting evapotranspiration, determination of crop coefficients, production functions, economics, and energy considerations. P, 450 or 455 or S.W. 520.

655. Surface Irrigation Analysis (3) I 1985-86 Analysis of design and operating criteria for basin, border and furrow irrigation systems, effect of field parameters on system design. Evaluation criteria of existing systems. P, 455.

656. Sprinkler Irrigation Analysis (3) II 1985-86 Analysis of design and operating criteria for intermittent and continuously moving sprinkler systems, hydraulics of sprinkler pipe systems, system evaluation, requirements of sprinkler heads. P, 456.

657. Trickle Irrigation Analysis (3) II 1986-87 Analysis of design and operating criteria for trickle or drip irrigation systems, hydraulics of emitters and pipe systems. P, 456.

696. Seminar a. Soils, Water and Engineering (1) [ Rpt./1] III (Identical with S.W. 696a, which is home) Wiersma

Soil and Water Science

The department offers opportunities for study toward the Master of Science and Doctor of Philosophy degrees with a major in soil and water science. Concentrations for soil and water science majors are available in soil fertility; soil chemistry; soil physics; soil microbiology; soil conservation; soil classification; water quality; irrigation; water resources development; waste management and pollution control in relation to soil, water, and air resources.

Students with adequate undergraduate preparation in engineering, physical sciences, or biological sciences will be considered for admission to an appropriate 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.

402. Introduction to Pesticides and Their Use (2) GC II (Identical with Pl.P. 402 )

405. Hydrology of Unsaturated Media (3) GC I (Identical with Hydr. 405 )

411. Soil Chemistry (3) GC I Soil chemical interactions with water, air, plants and pollutants. P, 200, Chem. 103b, 104b. Bohn

431. Soil Morphology, Classification and Survey (3) GC 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, Geos. 101a. Post

453. **Remote Sensing in Agriculture** (3) GC I Multispectral remote sensing techniques and applications in inventory, monitoring and analysis of soils, plants and related agricultural areas. 2R, 3L. Field trips. P, 330 or Phys. 102b.


470. **Soil Physics** (3) GC 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 or CR Math. 125a. Warrick

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 Trip. Dutt

505. **Chemical Analysis of Soils and Plants** (4) II Principles and methods of chemical analysis of soils, water and biological materials with emphasis on instrumental techniques. 2R, 6L. P, Chem. 322, 323; Phys. 102b, 180b. Hendricks

520. **Evapotranspiration** (3) I Theories and concepts of potential and actual evapotranspiration in arid regions; measurement and estimation methods, and plant growth-evapotranspiration relations. P, Math. 125b, Phys. 102b.

541. **Soil Genesis** (3) II Physical and chemical processes and mineralogy of weathering and soil formation; quantitative pedology; the soil as part of the ecosystem. Field trips. P, Geos. 101a and Chem. 103b. (Identical with Geos. 541) Hendricks

565. **Hydrochemistry** (3) II 1985-86 Solute composition of naturally-occurring waters, chemical reactions affecting the solute content of water, relations and effects of above on water quality criteria and pollution, analytical procedures used by water testing laboratories. 2R, 3L. P, Chem. 322 or C.E. 371 or 471. (Identical with Hydr. 565 and Ws.M. 565) Dutt

595. **Colloquium**
   a. **Current Subjects in Soil Science and Agricultural Engineering** (1) [Rpt./3] II


611. **Advanced Soil Chemistry** (3) I 1986-87 Soil physical chemistry and the chemistry and experimental methodology relating to soil minerals. P, 411. Bohn

696. **Seminar**
   a. Soils, Water and Engineering (1) [Rpt./1] II (Identical with A.En. 696a)

**SOUTHWEST STUDIES**

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 Professor Donald Weinstein in the Department of History.
SPANISH AND PORTUGUESE

Professors Alicia de Colombi-Monguió, Head, Rupert C. Allen, Leo L. Barrow, A. Dolores Brown, Jack Emory Davis (Emeritus), Juan J. Gilabert, Lanin A. Gyurko, Herman Iventosch (Emeritus), Ruth Lee Kennedy (Emerita), Richard P. Kinkade, John W. Martin, Dana A. Nelson, José Promis, Eliana S. Rivero, Renato I. Rosaldo (Emeritus), Robert ter Horst
Associate Professors Gilbert E. Evans, Karl C. Gregg, H. Reynolds Stone
Assistant Professors Armando Miguélez, Karen L. Smith

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/Master of Education elsewhere in this catalog. The department offers doctoral minors in Portuguese and Spanish. The department also participates, through the Committee on Romance Languages, in offering an M.A. with a major in Romance languages (see Romance Languages elsewhere in this catalog.

Admission to all graduate programs requires the completion of a bachelor’s degree with a strong major in the proposed field of study. Applicants must submit scores on the advanced Spanish test of the Graduate Record Examination. Admission to a doctoral program is dependent upon the completion of a Master of Arts degree with the same major.

Degrees

MASTER OF ARTS (Major in Spanish) — 33 units in one of four concentrations.

1. Spanish literature: 21 units of Spanish literature and 12 units of Spanish American literature.
2. Spanish American literature: 21 units of Spanish American literature and 12 units of Spanish literature.
3. Spanish language and linguistics: 9 units of pedagogy, 9 units of linguistics, 6 units of language, and 9 units of literature.
4. Hispanic studies: (Available in Guadalajara Summer School only) 21 units of literature in Spanish and 12 units from supporting fields.

DOCTOR OF PHILOSOPHY (Major in Spanish) — 32 units of 500-level coursework beyond the Master of Arts in addition to the dissertation. All students must pass a qualifying examination in Spanish and Spanish American literature equivalent to the final examination for the Master of Arts degree.

At the time of catalog publication, curriculum revision was under consideration by the Department of Spanish and Portuguese. For current information, contact your adviser.

Spanish

400a-400b. Survey of Spanish Literature (3-3) GC 400a : From the beginning through the 17th century. 400b: 18th-20th centuries. P, 306. 400a is not prerequisite to 400b.

401a-401b. Survey of Spanish-American Literature (3-3) GC 401a: From the beginning through the 18th century. 401b: 19th and 20th centuries. P, 306. 401a is not prerequisite to 401b.

402. Survey of Mexican Literature (3) GC S Major works by Mexican writers. Offered in Guadalajara only. P, five semesters of Spanish.

405. Advanced Composition and Conversation (3) GC I II Study and practice in formal discussion and expository writing. P, 375.

414. Teaching of Modern Languages (3) GC I II (Identical with S.Ed. 414 )

422. Introduction to Romance Philology (3) GC I 1986-87 Survey of the development of the modern Romance tongues from the Latin language. P, knowledge of two Romance languages. (Identical with Fren. 422, Ital. 422, Port. 422, and R.Lg. 422)

423a-423b. Theory of Spanish Syntax (3-3) GC 423a: Introduction to grammar as a theoretical construct; principles of transformational generative grammar exemplified in Span.; examination of traditional grammatical concepts in the new framework. 423b: More detailed and further-ranging analysis of Span. grammar within the general theory. P, 370. (Identical with Ling. 423a-423b)


427. Applied Spanish Linguistics (3) GC I Pedagogical applications of syntactic theory; introduction to phonological theory of Span. for pedagogical purposes; applied phonetics. (Identical with Ling. 427)

430. Spanish Civilization (3) GC I Spanish milieu; geographical, political, and cultural aspects of Spanish civilization.

431. Spanish-American Civilization (3) GC II Spanish-American milieu; geographical, political, and cultural aspects of Spanish-American civilization.


447. Contemporary Mexican Literature (3) GC II S Major novelists of modern Mexico; their works, narrative perspective, characterization, language, time, space, and themes. P, five semesters of Span. P, 306. (Identical with M.A.S. 447)

450. Spanish-American Short Story (3) GC S Development of the modern short story in Latin America, with examples from various countries and authors. Offered in Guadalajara only. P, five semesters of college Span.


473. Spanish for the Bilingual Classroom Teacher (3) GC II Practical Span. for the elementary and secondary school subject-matter teacher who uses Span. as the medium of instruction. P, 370 and 375. (Identical with M.A.S. 473)

495. Colloquium g. Hispanic Literature (3) GC [ Rpt./1] S Offered in Guadalajara only. P, 375.

510. Bibliography (3) II 1985-86 Bibliographical methods and principal bibliographies.

511. Literary Theory and Criticism (3) II 1986-87 Historical survey of theoretical writings on literature, with their implications for practical criticism,

540. Introduction to Medieval Literature (3) I 1986-87 Close study of the Poema de mio Cid, Berceo's Milagros, Juan Manuel's Conde Lucanor, selections from Juan Ruiz's El libro de buen amor, and from Santillana's poems.

541. Major Medieval Authors (3) I 1985-86 Representative works from the 11th to the 15th century and their current critics.

550. Spanish American Lyric Poetry from Colonial Times through Independence (3) I 1986-87

551. Spanish American Lyric Poetry from the 1830s through the 1920s (3) II 1986-87

552. Spanish American Lyric Poetry from the 1930's to the Present (3) I 1985-86


554. Spanish American Narrative from the 1830's through the 1920's (3) II 1985-86 Novel, short story, narrative poetry, and the articulo de costumbres.

312 DEPARTMENTS AND COURSES OF INSTRUCTION

556. Spanish American Theatre (3) II 1985-86 Major dramatic works from Colonial times to the present.


558. Golden Age Prose (3) II 1986-87 The Celestina, chivalric, picaresque, and pastoral novel from the late 15th through the 17th century.

559. Golden Age Poetry (3) II 1985-86 The major poets from the early 16th through the 17th century.

560. Golden Age Theatre (3) I 1985-86 The major dramatists from the early 16th through the 17th century.

561. Neoclassicism and Romanticism (3) I 1986-87 The emergence of Spanish Romanticism from the Enlightenment.

562. Realism and Naturalism (3) II 1986-87 Major prose writers of the 19th century from Galdós to Blasco Ibáñez.

563. The Generation of '98 (3) II 1985-86 Major literary expressions concerning the problems of Spain and the Spaniard from the late 19th century to 1936.

564. Contemporary Spanish Novel (3) II 1986-87 The novel since the Civil War.

565. History of the Spanish Language (3) I 1985-86

566. Spanish in the Americas (3) II 1986-87

679a-679b. Problems of Teaching College Spanish (1 to 3 - 1 to 3) Problems encountered in teaching basic language courses. Units cannot be used to satisfy departmental graduate degree requirements.

696. Seminar
   a. Philology and Linguistics (3) I II
   b. Spanish Literature (3) I II
   c. Spanish American Literature (3) I II

Portuguese

400a-400b. Survey of Brazilian and Portuguese Literature (3-3) GC 1986-87 400a: Brazilian literature. 400b: Portuguese literature. P, 201b or 202b.

402a-402b. Brazilian Civilization (3-3) GC P, 201b or 202b.

405a-405b. Advanced Composition and Conversation (3-3) GC Two hours conversation, one hour composition. P, 201b or 202b.

422. Introduction to Romance Philology (3) GC I 1986-87 (Identical with Span. 422 )

463. Studies in Brazilian Literature (3) GC I 1985-86 Major works, authors and tendencies in modern Brazilian literature. P, 201b or 202b.

464. Studies in Portuguese Literature (3) GC II 1985-86 Major works, authors and tendencies in the literature of Portugal. P, 201b or 202b.

696. Seminar
   a. Portuguese Literature (3) [ Rpt. ] I II
   g. Brazilian Literature: 16th-18th Centuries (3) I II
   h. Brazilian Literature: 19th Century (3) I II
   i. Brazilian Literature: 20th Century (3) I II

SPECIAL EDUCATION

Professors James C. Chalfant, Head, Sidney W. Bijou, William C. Healey, Samuel A. Kirk, Jeanne McRae McCarthy
Associate Professors C. June Maker, John Umbreit
Assistant Professors Shirin Antia, Candace Bos, Anthony K. Van Reusen, Aldine S. von Isser
The department offers programs leading to the Master of Arts, Master of Education, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in special education. Concentrations are available in behaviorally disordered, hearing impaired, early childhood handicapped, learning disabilities, mental retardation, multiple and severely handicapped, visually handicapped, or special education administration. By judicious choice of electives and individual studies, a considerable emphasis on multicultural education may also be developed.

For full graduate admission, applicants must ordinarily have completed a bachelor's degree with a major in elementary, early childhood, secondary, or special education or in speech and hearing sciences with a grade-point average of at least 3.00. In some cases, however, applicants with other undergraduate majors may be admitted, and students with undergraduate grade-point averages of 2.50 or higher may be admitted to provisional standing. Applicants for admission to full-time programs beginning with the fall semester must complete their applications by March 1 of the preceding spring. The hearing impaired program requires two years to complete. Applicants for admission to the specialist or doctoral programs must submit scores on the aptitude and advanced education tests of the Graduate Record Examination, personal data blanks, and letters of reference to the Office of Graduate Studies in Education.

All graduate degree candidates must complete Ed.F.A. 603 or obtain an official waiver from the Educational Foundations and Administration Department to demonstrate equivalent preparation in research. Doctoral candidates must complete Ed.P. 640. A thesis is required for the Master of Arts degree. Students working for the Doctor of Philosophy degree must complete course work in two related areas which may be an approved six-unit sequence in computer programming or a twelve-unit sequence in statistics and research methods or a nine-unit program in cognate areas such as anthropology, psychology, and sociology. Specific requirements for other degree programs may be obtained by writing to the department. For further information concerning these degree programs see Requirements for Graduate Degrees elsewhere in this catalog.

At the time that the catalog was being edited, the College of Education was undergoing review. Because of this, it is important that students check with their major adviser to assure that they understand any changes which may have been made as result of the review.

403. Study of Exceptional Children (3) GC I II Incidence, characteristics, and educational problems of exceptional children. (Identical with Ed.F.A. 403, Elem. 403 and S.Ed. 403)

407. Introduction to Learning Disabilities (3) GC I II Theories and history of programs for the learning-disabled — definition, characteristics, etiology. Departmental degree candidates must complete 403 prior to taking 407.

408. Diagnosis and Remediation of Learning Problems (3) GC I II Educational and psychological assessment of children and youth with learning problems; development of competencies required to teach such populations. P, 403 or CR. Not open to students in the learning disabilities concentration.

410. Vision and Visual Functioning (3) GC I II Anatomy and physiology of the eye; visual development, assessment and training; relationship of visual defects to learning and school experiences.

413. The Sensory Impaired (3) GC I Current and historical perspectives; etiology, psychosocial, cognitive, and motor development of hearing impaired, visually impaired and sensory impaired multiply handicapped children and youth.

419. Behavior Principles for the Handicapped (3) GC I II Use of behavior principles to modify the behavior of handicapped persons, especially moderately and severely handicapped. 3R,1L. P, 403. (Identical with Rhab. 419)

423. The Special Education Teacher (3) GC I II S Information to aid teachers in dealing with responsibilities and concerns in school settings with regard to P.S. 94-142, Education for All Handicapped Children Act.

427. Bilingual/Bicultural Education Curriculum Development (3) GC I II (Identical with Ed.F.A. 427)
34

DEPARTMENTS AND COURSES OF INSTRUCTION

458. Education of Gifted Children (3) GC I Issues in education of the gifted; discussion of definitions, characteristics, development, screening, identification, curriculum, teaching strategies, and program development.

470. Mental Retardation (3) GC I II History and philosophy of educational programs for the mentally retarded and other developmentally disabled; etiology, classification, and characteristics, with consideration of educational, social, and interpersonal problems. P, 403 or CR.

473. Education of Children with Behavioral Disorders (3) GC I Educational programs for children and youth who are emotionally disturbed or socially maladjusted. P, 403.

487. Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487)

488. Microcomputer Application in Education (3) GC I II S (Identical with Ed.F.A. 488)

495. Colloquium g. Introduction to Early Childhood Education for the Handicapped (1) GC I P, 403.


505. Methods of Teaching the Learning-Disabled (3) II Remediation of academic areas and learning processes involving perception, integration, and expression, with emphasis on methods of planning and implementing instructional programs. P, 407, 506, and permission of dept.; CR 593 and 594.

506. Methods for Diagnosing Specific Learning Disabilities (3) I Educational and psychological assessment of academic areas and learning processes involving perception, integration, and expression, with emphasis on testing and diagnostic teaching. P, 407 or CR and permission of department; CR 593 and 594.

508. Methods and Materials for Hearing Impaired (3) I II Teaching of reading and school subjects to hearing impaired children; demonstrations and practice with hearing impaired children. CR 593.


514. Methods of Teaching the Visually Handicapped (3) I 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 reading, writing, and mathematics. CR 593.


526. Methods and Materials in Bilingual Education (3) GC I II (Identical with Elem. 526)

550. Administration and Supervision of Special Education Programs (3) II Practical aspects of organization and development of special education programs; problems of public relations, personnel, case finding, evaluation, placement, and records. P, consult department before enrolling.

552. Language Disorders in School Age Children (3) II S (Identical with Sp.H. 552)

573. Teaching Children with Behavioral Disorders (3) II Various methods and techniques for teaching the emotionally disturbed. P, 473.

575. Observation and Participation in Special Education Programs (1 to 3) I II Specific types of exceptional children, psychological and educational implications and practices. Field trips, class observations and seminars. P, 403. Special sections in each category of the exceptionality to be arranged in the departmental office.

581. Language Development for the Exceptional Child (3) I Pragmatic, semantic and syntactic aspects of language development in exceptional children and youth; cognitive and social bases for intervention.

582. Teaching Language to Hearing Impaired (3) II Receptive and expressive language assessment; techniques of teaching language to hearing impaired children and youth.

585. Speech for the Hearing Impaired (3) II Oral/aural communication development; methods for assessing and teaching speech and auditory skills.

593. Internship (1 to 10) I II Note: Special sections in each category of the exceptionality to be arranged in the departmental office.
594. Practicum
   b. Communication Development for Hearing Impaired Children (1 to 6) I II

595. Colloquium
   a. Behavioral Disorders (3) I Open to majors only.
   c. Mental Retardation (3) I P, 403.

597. Workshop
   a. Personal Management and Daily Living Skills for the Visually Handicapped (1 to 3) GC I II
   b. Orientation and Mobility of the Visually Handicapped (1 to 3) GC I II
   g. Creativity and Giftedness (3) [Rpt./9 units] II

616. General School Administration (3) I (Identical with Ed.F.A. 616)

620. Applied Research with Preschool Children (3) II Review of principles and practices underlying applied research with exceptional children; practice in preparation of research proposals; conduct of research emphasized.

621. Methods of Teaching Preschool Handicapped (3) II Deals with competencies required to teach all categories of handicapped preschool children except deaf/blind. Field trips. P, 575, 622, 495g, 695h.


623. Multidisciplinary Approaches to Preschool Handicapped (1) I Exploring the roles of the interdisciplinary team within the framework of an educational service delivery system. P, 403; CR 575.

624. Working with Families of Young Handicapped Children (1) II Varying strategies for developing family training programs and promoting effective parent-teacher relationships. P, 403, 495g.

625. Application of Child Development Research to Exceptional Children (1) II Relevant research in the areas of delivery systems, origins of human competence, sensorimotor processes, perception, memory, communication, cognitive structures and operations, affective processes, child abuse, genetics and twin studies, and impact of the family on young handicapped children. P, 403, 495g.

664. Theory and Behavior in School Administration (3) II (Identical with Ed.F.A. 664)

671. School Finance (3) I (Identical with Ed.F.A. 671)

675. The Law and American Education (3) I (Identical with Ed.F.A. 675)

695. Colloquium
   a. Recent Advances in Special Education (1 to 4) I II
   b. Behavior Disorders (1 to 4) I II
   c. Issues and Trends in Special Education (1 to 4) I II
   d. Learning Disabilities (1 to 4) I II
   e. Mental Retardation (1 to 4) I II
   f. Sensory Impaired (1 to 4) I II
   l. Issues and Research in Educating the Gifted (3) [Rpt./9 units] II Consult department before enrolling.
   m. Language, Learning and Reading Disabilities (3) II (Identical with Sp.H. 695m, Rdng. 695m)

SPEECH AND HEARING SCIENCES


Associate Professor Linda Swisher

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in speech and hearing sciences.

Admission requirements include the completion of a minimum of 24 undergraduate units in speech and hearing sciences. Applicants must complete departmental application forms and submit three letters of recommendation. Scores on the aptitude test of the Graduate Record Examination are required of all applicants to the graduate program, and doctoral applicants must also submit a sample of their scholarly writing. Ordinarily, completion of the master's degree is prerequisite to admission to the doctoral program.
The Master of Science program requires the completion of 36 units of course work. Submission of a thesis as a part of the program is optional. The Doctor of Philosophy degree is designed to provide the tools, knowledge, and experience in research and not to provide specialization in clinical pursuits.

### 450. Structure of Speech and Language (3) GC I
- Study of the nature of language and linguistics; current approaches in linguistics.

### 451. Acquisition of Speech and Language (3) GC II
- Normal development of speech and language in the child; relationships with cognitive and social development. (Identical with Ling. 451)

### 458. Introductory Clinical Studies: Speech-Language Pathology (1 to 3) [ Rpt./9 units] GC I II S
- Basic clinical procedures for managing a limited range of speech and language disorders. Includes observation and supervised practice. Open to majors only. P, 451 or CR 471.

### 459. Introductory Clinical Studies: Audiology (1 to 3) [ Rpt./9 units] GC I II S
- Procedures for identifying and managing a limited range of hearing losses in children and adults. Includes observation and supervised practice. Open to majors only. P, 483 or CR.

### 461R. Speech and Hearing Science Instrumentation (2) GC I
- Consideration of some common and specific instruments and methods employed in speech and hearing labs. and clinics. P, 260, 280 or CR.

### 461L. Speech and Hearing Science Instrumentation Laboratory (1) GC P, CR 461R.

### 471R. Articulation Disorders and Therapies (2) GC II
- Etiology, diagnosis, prognosis, and therapy for the articulatory aspects of communication problems. P, 370; 367; CR or subsequent registration in 471L (for majors).

### 471L. Laboratory in Articulation Disorders (1) GC I
- Open to majors only. P, 471 R or CR.

### 479. Speech and Hearing Disorders for Related Professions (3) GC I II
- Recognition and management of language, speech and hearing problems for related professions such as education, nursing, psychology, and speech communication. Open to nonmajors only.

### 483. Audiometry (3) GC I

### 484. Audiol ogic Rehabilitation: Adults (3) GC II
- Speech reading; auditory training; problems encountered with amplification units; social, psychological, educational, speech, and language difficulties encountered by the hearing handicapped. P, 260, 483.

### 486. Child Audiology (3) GC II
- Study of the development and disorders of the auditory system; audiometric evaluation and differential diagnosis in infants and children; psychological, auditory, and educational aspects of the habilitation of aurally handicapped children. P, 280, 483.

### 497. Workshop a. Speech, Language and Hearing Problems in Children and Adolescents (3) GC S
- Field trips.

### 500. Introduction to Graduate Study (3) I
- Introduction to the conduct of research and grad. study in speech and hearing sciences.

### 510. Counseling Techniques in Communication Disorders (3) GC II S
- Basic counseling techniques pertinent to clinical practice with the communication handicapped and their families.

### 552. Language Disorders in School Age Children (3) II S
- The nature and treatment of language disorders in children from grades K-12; relationships between language and learning disorders; assessment and treatment strategies. P, 451 (Identical with Spec. 552)

### 553R. Language Disorders in Preschool Children (2)
- Etiology, evaluation and therapy for children with delayed language and/or language disabilities; relationships with learning disabilities; dialect and bilingualism.

### 553L. Laboratory in Preschool Language Disorders (1) II

### 554R. Adult Aphasia (2)
- Etiology, evaluation and therapy for language disorders associated with brain damage. P, 370; 450 or 451; CR or subsequent registration in 554L (for majors).

### 554L. Laboratory in Adult Aphasia (1) II

### 558a-558b. Intermediate Clinical Studies: Speech-Language Pathology (1 to 3 - 1 to 3) [ Rpt./9 units] II S
- Under faculty supervision, students assess speech and language functioning, 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, 471.
559. Intermediate Clinical Studies: Audiology (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. P, 483.

560a-560b. Experimental Phonetics (3-3) 560a: 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. 560b: Systematic examination of current experimentation and research in speech as an acoustical phenomenon; critical evaluation of research design. P, 260, 461. 2R, 3L. 560a is not prerequisite to 560b.

565R. Aerodynamic Evaluation and Management of the Speech Mechanism (2) II Principles and clinical methods of aerodynamic evaluation and management of the disordered speech mechanism, with practical experience provided through case studies and class experiments. P, 260, 461, 560a.


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.

571. Cleft Palate, Other Craniofacial Disorders, and Communication (2) I Communication disorders associated with cleft palate and other craniofacial defects. Speech assessment, evaluation and treatment; survey of dental and surgical services.

572R. Disorders of Phonation (2) I Etiology, diagnosis, prognosis, and therapy for disorders of voice; speech for the laryngectomized. P, 260.

572L. Disorders of Phonation Laboratory (1) I Open to majors only. P, 572R or CR.

573R. Disorders of Fluency (2) II Primarily a study of stuttering: identification, nature and assessment; theoretic considerations; management approaches; proportionate attention to other anomalies of fluency. P, 370; CR or subsequent registration in 573L (for majors).

573L. Laboratory in Disorders of Fluency (1) I II Open to majors only. P, 573R or CR.


576. Communicative Aspects of Aging (2) II Hearing, speech, voice, and language changes in the elderly caused by aging and disease. Emphasis on management of these problems. (Identical with Gero. 576)

579. Organization and Administration of Speech and Hearing Programs (3) II Problems in organizing a speech and hearing program: philosophy, case load, space, staff, budget, interagency cooperation.

580. Industrial Audiology (2) II Auditory and non-auditory effects of noise, industrial hearing conservation, noise measurement and control.

581. Evaluation and Selection of Hearing Aids (3) I Development of hearing aid evaluations; circuitry of hearing aids and their physical characteristics; speech intelligibility and the electroacoustics of low-fidelity circuitry; patient evaluation and counseling. P, 483; CR or subsequent registration in 494b (for majors).

582. Disorders of Hearing (3) II Pathologies of the hearing mechanism and their auditory manifestations in both adults and children. P, 280, 483.

583. Special Auditory Tests (3) II Special audiologic procedures to differentiate conductive versus sensorineural, sensory versus neural, central versus peripheral, and organic versus functional hearing disorders. Open to majors only. P, 483, 582.

584. 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 589.

585. Physiological Acoustics (3) I Study of contemporary auditory theory and its historical development; theories related to the function of physiological and neurological mechanisms in the light of empirical findings; psychophysical findings related to physiological findings. 2R, 3L. P, 280.
318 DEPARTMENTS AND COURSES OF INSTRUCTION

586. Electrophysiologic Evaluation of the Auditory and Vestibular Systems (3) II Techniques, normative data, and clinical interpretation of auditory-evoked potential and electronystagmography tests. 2R, 3L.

587. 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. 2R, 3L. P, 280, 461.

589. Principles of Audiology (3) I Basic techniques of pure-tone audiometric testing; interpretation of audiograms; disorders of hearing; anatomy and physiology of the hearing mechanism; basic acoustics. Open to nonmajors only.

596. Seminar
a. Experimental Phonetics (1 to 3) [ Rpt./2 or 9 units] I II
b. Clinical Audiology (1 to 3) [ Rpt./2 or 9 units] I II
c. Hearing—Physiology and Psychophysics (1 to 3) [ Rpt./2 or 9 units] I II
d. Language and Language Disorders (1 to 3) [ Rpt./2 or 9 units] I II
e. Speech Pathology (1 to 3) [ Rpt./2 or 9 units] I II

658a-658b. Advanced Clinical Studies: Speech-Language Pathology (1 to 3 - 1 to 3) [ Rpt./9 units] I II S 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. 658b is in an extern setting. P, 471, 553.

659. Advanced Clinical Studies: Audiology (1 to 3) [ Rpt./9 units] I II S 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, 483.

693. Internship
a. Speech Pathology (1 to 6) I II Open to majors only. P, 494a.
b. Audiology (1 to 6) I II Open to majors only. P, 494b.
c. Language, Learning and Reading Disabilities (3) II (Identical with Spec. 695m, which is home.)

SPEECH COMMUNICATION

Professors Judee K. Burgoon, Michael Burgoon, Henry L. Ewbank, Andrew A. King, Frank K. La Ban, Klonda Lynn (Emerita), Alethea S. Mattingly (Emerita)
Associate Professors David A. Williams, Acting Head, James W. Davis, Mary Z. Maher, Ronald J. Matlon, Robert W. Sankey, Patricia D. Van Metre

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in speech communication. Work leading to the Master of Education degree with a major in speech 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 thesis or non-thesis, and the interdisciplinary program with thesis or non-thesis. Students must complete a minimum of 31 units, including four thesis units, or 36 units in the non-thesis option. Those electing a departmental program may count a maximum of three units taken outside of the department toward the required minimum. Those electing an interdisciplinary program (e.g., organizational communication concentration) must take a minimum of nine units outside of the department. Three units of internship and/or independent study may be included in any required minimum.

Doctoral students must complete at least 27 units of course work in the major (beyond the requirements for the Master of Arts degree) plus the dissertation, the requirements for a minor, and must demonstrate proficiency in a scholarly research tool. A maximum of six units of internship and/or independent study, including those counted toward the Master of Arts degree, may be included in the required minimum.

Students in the master's and doctoral programs are required to complete courses 610, 620, 660, and 670.

In addition to 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. Applicants for admission to the doctoral program must submit a master's thesis or other evidence of scholarly writing.

412a-412b. Organizational Communication (3-3) GC Analysis of interpersonal and group communication practices affecting goal achievement in business, governmental, and professional organizations. 412a: Theory. 412b: Process. P, 300 or M.A.P. 305.

414. Classical Rhetorical Theory (3) GC I Intensive reading and analysis of the works of major Greek and Roman rhetorical theorists. P, 325 or CR.

416. Modern Rhetoric (3) GC II 1986-87 Intensive reading and analysis of the works of major rhetorical theorists from the 16th century through the present. P, 414.

417. Relational Communication (3) GC II The relational communication process and messages people use to define interpersonal relationships, including dominance-submissiveness, affection, involvement and similarity.

418. Persuasion (3) GC I II Theories of audience analysis and the motivation of human conduct: the study of rhetorical devices.

420. Speech Communication in the Legal Process (3) GC II Analysis of communication questions and skills facing lawyers, judges, litigants, and jurors. Application of speech communication theories to legal concerns of interview, negotiation, and litigation. Field trips.

422. Rhetoric of the British Empire (3) GC II 1986-87 Significant public argument in the British Empire, with emphasis on the political, social and economic issues in the “Golden Age” of rhetoric: Chatham, Burke, Pitt, and Fox. P, 325, 414.

424a-424b. American Public Address (3-3) GC 424a: II 1985-86 History and criticism of American religious and reform speakers from Colonial times to the present. 424b: II 1986-87 Analysis of American political speaking from 1785 to the present. P, six units of speech. 424a is not prerequisite to 424b.

436. Shakespeare through Performance (3) GC I Understanding Shakespeare’s plays through performance. Performance-oriented analysis compels a thorough comprehension of the ideas, emotions, attitudes and intent of the plays being studied. P, 237 or 238 or 200 level drama course. (Identical with Dram. 436)

445. Oral Interpretation of Poetry (3) GC I Types of poetry analyzed, with emphasis on their differentiation for oral presentation; preparation for and presentations of a public recital. P, 136.

446. Oral Interpretation of Fiction (3) GC II Analysis of short stories and selected short novels, with emphasis on point of view, tone, and characterization in preparation for performance. P, 136.

447. Studies in Group Reading (3) GC I 1986-87 Study in forms, styles, and aesthetics of Readers Theatre, Chamber Theatre, and the documentary; examination of essay, biography, short fiction, novel, and dramatic literature for group reading. P, three units of speech, dram. or Engl.

453. Theories of Small Group Communication (3) GC I Theories of small group communication, their research backgrounds, and their relevance to communicative interaction in small groups. P, 303 or 313.

462. Communication and Human Relationships (3) GC S An advanced course enabling students to inventory, evaluate, and develop oral communication skills in the interpersonal, group, and organizational dimensions of their lives.

467. English Phonetics (3) GC I II Scientific study of the sounds of speech; emphasis on laws and principles determining articulatory features, dialect variation, sound change, and sound as communication context.

525. Rhetorical Criticism (3) I 1985-86 Systems of criticism; rationale of approaches to the critical act; analysis of representative criticism of rhetorical events and movements.

567. Applied Phonetics (3) II 1986-87 Analysis of English dialect variations, with emphasis on interviewing procedures forming the basis of the Linguistic Atlas of the United States and on determining and modifying dialect forms of nonnative speakers of English; atlas field projects and tutorial work with nonnative speakers of English. P, 467 or ability to transcribe phonetically.

610. Rhetorical and Communication Theory I (3) I Historical development of theoretical and pedagogical perspectives on the process of generating and understanding public discourse.

620. Rhetorical and Communication Theory II (3) II Contemporary approaches to the process of human communication, psychological, philosophical, linguistic, literary, behavioral, and other perspectives.
636. **Interpretation of Individual Literary Styles (3)** I 1986-87 Intensive critical study of selected writings of one or two significant premodern and modern literary figures in terms of the oral presentation. P, 136, and six additional units in interpretation.

637. **Historical Theories of Oral Interpretation (3)** II 1985-86 Mechanical and natural schools of oral interpretation, their backgrounds, and their influence upon modern teaching and performance.

638. **Modern Theories of the Performance of Literature (3)** II 1986-87 Twentieth-century theories of interpretation and their application, with emphasis on developing a rationale for criticism of performed literature.

660. **Research Methodologies I (3)** I Historical and critical methods of investigating, analyzing, and evaluating rhetoric and literature. (Identical with Jour. 660)

661. **Research Methodologies II (3)** II Experimental, descriptive, statistical, and computer-assisted methods of investigating, analyzing, and evaluating human communication. (Identical with Jour. 670)

696. **Seminar**
   - **a. Rhetorical Criticism (3)** [Rpt./1] III
   - **b. Oral Interpretation (3)** [Rpt./1] III
   - **c. Rhetorical Theory (3)** [Rpt./1] III
   - **d. Speech Education (3)** [Rpt./1] III
   - **e. Communication Theory (3)** [Rpt./1] III
   - **f. Linguistic Investigations and Applications (3)** I II (Identical with Ling. 696f)
   - **g. Argumentation (3)**

**STATISTICS**

Professors Jean E. Weber, Head, Bruno Baldessari
Assistant Professor Michael Trosset

The department offers a program leading to the Master of Science degree with a major in statistics. A thesis is not required, but up to six units may be earned by those who wish to write one.

461. **Elements of Statistics (3)** GC I II Advanced degree credit available for nonmajors only. (Identical with Math. 461)

464. **Theory of Probability (3)** GC I (Identical with Math. 464)

465. **Statistics for the Medical Sciences (4)** GC I Standard and nonparametric one- and two-sample procedures, ANOVA designs, linear and multiple regression, bioassay, probit analysis, and contingency tables. 3R, 3L. Not open to majors. P, two semesters of calculus. (Identical with Tox. 465)

466. **Theory of Statistics (3)** GC II (Identical with Math. 466)

468. **Applied Stochastic Processes (3)** GC II (Identical with Math. 468)


563. **Nonparametric Statistics (3)** I Distribution free statistics, chi-square tests, related samples, independent samples, correlations, tests of significance, confidence bands. P, one course in stat.

567a-567b. **Statistical Inference (3-3)** 1985-86 (Identical with Math. 567a-567b)


663. **Advanced Statistical Methods (3)** I Statistical inference in linear models; point and interval estimation and tests of hypotheses in linear regression, discriminant analysis and analysis of variance; nonparametric inference. P, 466.

664. **Applied Multivariate Analysis (3)** II Consideration of multivariate statistical analyses, with emphasis on applications, interpretation of computer printouts and effects of violations of model assumptions. P, 660.
### Applied Time Series Analysis (3)
Methods used in time series analysis, with emphasis on applications, including computer analysis of data and consideration of violations of model assumptions. P, 660.

### Systems and Industrial Engineering

Professors John S. Ramberg, **Head**, A. Terry Bahill, Lucien Duckstein, William R. Ferrell, Donald G. Schultz, Roger J. Weldon (*Emeritus*), A. Wayne Wymore, Sidney J. Yakowitz

Associate Professors Robert L. Baker, Duane L. Dietrich

Assistant Professors Thuruthickara C. John, Joseph J. Pignatiello, Jr., Suvrajeet Sen

The department offers programs leading to the Master of Science degree with majors in systems engineering or industrial engineering and leading to the Doctor of Philosophy degree with a major in systems engineering.

Normally, the graduate student has a background in engineering, mathematics, or physics. In addition, a special program is available to students with bachelor's degrees in areas other than engineering or the physical sciences. Programs vary in length from one to two and one half years, depending upon background.

For the Master of Science degree, at least eighteen of the thirty units required must be taken within the department, and, of these, no fewer than twelve units must be in courses at the 500 level or above. An additional six units at the 500 level or above are also required. They may include six units of thesis, a three-unit master's report, or neither. The nature of the final oral examination depends upon the option selected. Additional details concerning the requirements of the master's or doctor's degree may be obtained on request from the department.

#### Digital Systems Simulation (3)
Simulation modeling of systems using digital computer languages, emphasizing random variate generation, Monte Carlo, timekeeping structures and statistical design and analysis of simulation experiments. P, 320b or CR 420.

#### Engineering Quality Control (3)
Single, double, multiple, and sequential sampling plans; acceptance sampling plans of the Department of Defense, Shewhart Control Charts; cu- sum control charts; applications of quality control concepts in reliability analysis. P, 320b or CR 420. (Identical with A.M.E. 406)

#### Reliability Engineering (3)
(Identical with A.M.E. 408)

#### Industrial Ergonomics (3)

#### Human Interaction with Computers and Software (3)
The interaction of technical requirements with the characteristics of computer users and programmers as they affect the design of software, and the physical and cognitive interfaces between people and computers. P, 310.

#### Engineering Statistics (3)

#### Engineering Decision Making under Uncertainty (3)
Application of principles of probability and statistics to the design and control of engineering systems in a random environment. Methodology includes utility theory, risk analysis and Bayesian decision analysis. P, 320b or CR 420.

#### Models in Operations Research (3)
Engineering applications of probabilistic models including Markov processes, queueing, inventory scheduling and decision theory. P, 320a.

#### Design of Delivery/Distribution Systems (3)
The design of distribution and delivery schemes using concepts of system theory, operations research, economics, statistics, and human factors; one case study is selected by the instructor, another one by the students. P, 320, 340, 405.

#### Deterministic Control Systems (3)
The analysis and synthesis of deterministic linear control systems, with emphasis on design using both frequency-domain and state-variable approaches. P, 350.
462. Production Systems Analysis (3) GC I Production systems, product and process design, forecasting, production planning models, inventory models, material requirements planning, facility layout and materials handling. P, 340.


465. Modeling Manufacturing Systems (3) GC II An intermediate level introduction to topics in hierarchical design, planning, and control of manufacturing systems and their applications. Topics include modeling automated transfer lines and flexible manufacturing systems. Attention will be given to the performance of manufacturing systems and operational issues such as the role of robots, flexible machines, computers, and material handling systems. P, 340b.

473. Concepts in Information and Communication Systems (3) GC II Introduction to signals and signal processing; signal representations; information measures and channels; modulation and demodulation, detection, estimation. P, 350.

474. Knowledge Engineering (3) GC I Building, using and evaluating expert systems. 2R, 3L.

475. Software Engineering (3) GC II Basic principles for medium-scale professional programming projects. Documentation, maintainability, portability, and verification. Source codes for word processing, games, spread sheets, etc. Programming project required. P, 270.


506. Advanced Quality Control and Reliability (3) II Applications of modern statistical theory in quality control and reliability. Topics include Bayesian decision theory; multivariate methods: Markov processes and selected papers from the recent literature. P, 406 and 420. (Identical with A.M.E. 506)

508. Advanced Reliability Engineering (3) II (Identical with A.M.E. 508)


518. Reliability Testing (3) II (Identical with A.M.E. 518)


540. Queueing Theory (3) I Application of the theory of stochastic processes to queueing phenomena; steady-state analysis of birth-death, Markovian and general single- and multiple-channel queueing systems; application of queueing models to production systems, computer and communication systems, airport, police patrol and firefighting.

544. Linear and Integer Programming (3) I II Revised simplex method, theory of polyhedra, duality theory, computational complexity, ellipsoid and related methods, integer programming formulations, branch and bound and implicit enumeration, Lagrangian relaxation, generation of valid inequalities.

550. Theory of Linear Systems (3) I An intensive study of continuous and discrete linear systems from the state-space viewpoint, including criteria for observability, controllability, and minimal realizations; and optionally, aspects of optimal control and filter theory. P, 350

554. Mathematical System Theory (3) I Mathematical theory of discrete systems and models for application to large-scale, complex, man-machine systems.

556. Finite State Methods in Water Resources Management (3) II (Identical with W.R.A. 556)

562. **Scheduling Theory** (3) I Introduction to problems of sequencing and scheduling for single, multiple, and parallel processor systems; discrete programming and heuristic procedures for flow-shop and job-shop models; network methods for project scheduling. P, 544.

563. **Facility Layout and Location** (3) II Mathematical characterizations of single and multifacility location models as minimum norm problems; mathematical programming methods for facility layout; investigation of computer-aided design systems. P, 544.

565. **Multi-Objective Analysis of Engineering Systems** (3) I Systems design versus operation; multi-objective simplex; goal programming and other distance-based techniques; multi-attribute utility; techniques with qualitative criteria; interactive, quaninteractive and dynamic approaches; model choice; resource engineering applications. P, 340b or 544.


620. **Selected Topics in Probabilistic Systems** (3) II Topics include Markov and semi-Markov processes; regenerative processes; Markov decision theory; application in queueing, production and computer communication systems. P, 520, 540.

640. **Advanced Queueing Theory** (3) II Analysis of stochastic models of complex queueing and production systems; transient and steady-state analysis of single stage and network of queues; application of complex queueing models to production systems such as flexible manufacturing systems and flow lines. P, 540.


**TOXICOLOGY**

*(See Pharmacology and Toxicology, College of Pharmacy)*

**TURKISH**

*(See Oriental Studies)*

**URBAN PLANNING**

*(See Planning)*

**URDU**

*(See Oriental Studies)*

**VETERINARY SCIENCE**


Associate Professors Ronald W. Hilwig, Lynn A. Joens, Charles R. Sterling

No advanced degree is offered in veterinary science. In cooperation with the Committee on Animal Physiology, the department offers course work and research direction for students working toward the Master of Science or the Doctor of Philosophy degree with majors in this discipline. In certain cases, similar cooperative arrangements may be made with the Departments of Entomology, Ecology and Evolutionary biology, or Microbiology and
Immunology. Students majoring in other disciplines may elect veterinary science as a doctoral minor with the approval of the major department.

400a-400b. Animal Anatomy and Physiology (3-3) GC Physiology, gross and comparative anatomy.  
400a: Nervous, musculoskeletal, immune, hemolymphatic, circulatory, and respiratory system of domestic animals.  
400b: Urinary, digestive, endocrine and reproductive systems P, Ecol. 104, Chem. 103a-103b, 104a-104b.

403R. Biology of Animal Parasites (3) GC I Biology of host-parasite relationships with emphasis on parasites of veterinary and human importance. Parasite morphology and physiology, life cycles, epidemiology, pathogenesis and zoonotic potential. P, eight units of biol. or micr. (Identical with Ento. 403R, Ecol. 403R, Micr. 403R)

405. Animal Diseases (3) GC I Integration of management, husbandry, and preventive veterinary medicine, as related to animal diseases.

415R. Physiology of Reproduction (3) GC I (Identical with An.S. 415R)

419. Introductory Immunology (3) GC I (Identical with Micr. 419)

420R. Pathogenic Microbiology (3) GC II (Identical with Micr. 420R)

420L. Pathogenic Microbiology Laboratory (2) GC II (Identical with Micr. 420L)

423R. General Pathology (3) GC II Pathogenesis, pathophysiology and morphologic changes of human and animal diseases. P, Micr. 420R. (Identical with Micr. 423R and Tox. 423R)

423L. General Pathology Laboratory (1) GC II Gross and histologic changes occurring in tissues and organs in selected human and animal diseases and disease processes. P, 423R or CR. (Identical with Micr. 423L and Tox. 423L)

438. Control of Infectious Disease (3) GC II (Identical with Micr. 438)

450. Medical Mycology (4) GC II (Identical with Micr. 450)

458. Comparative Vertebrate Anatomy (4) GC I Evolution and gross structure of vertebrate organ systems. 2R, 6L, P, eight units of animal bio. (Identical with Ecol. 458)

459. Comparative Vertebrate Histology (4) GC I Structure, identification and function of normal vertebrate tissues. 2R, 6L, P, eight units of animal bio. A vertebrate anatomy course is strongly recommended. (Identical with Ecol. 459)

489. Parasitology (4) GC S (Identical with Ecol. 489)

601. Experimental Surgery (2) II 1985-86 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, three units of mammalian anat.

630. Immunology (4) II 1986-87 (Identical with Micr. 630)

681. Biostatistical Methods in Microbiology (2) I (Identical with Micr. 681)

WATER RESOURCES ADMINISTRATION  
(See Hydrology and Water Resources)

WATERSHED MANAGEMENT  
(See Renewable Natural Resources)

WILDLIFE AND FISHERIES SCIENCE  
(See Renewable Natural Resources)

ZOOGOLOGY  
(See Molecular and Cellular Biology, Ecology and Evolutionary Biology)
Index

Abbreviations, 9-10, 88
Absentia, work in, 62
Academic calendar, 11-13
Academic deficiencies, 57, 59
Academic divisions, 8
Academic requirement, assistantships, 63
Academic scholarships, graduate, 63
Accommodation of religious observance and practice, 43
Accounting courses, 90
Master of, 68
Administration
Business, 122
educational, 150
public, 216
University, 14-16
Administrative drop, 60
officers, 14
Admission, 57
application, 58
equal opportunity, 4
foreign students, 57
general regulations, 57
readmission, 58
transfer of credits, 60
Advanced degrees, 64-66
candidacy for, 59, 80, 83, 85
offered, 66
Advancement to candidacy, 59, 80, 83, 85
Advisory committee, 76, 82, 84
Aerospace and Mechanical Engineering, 91
Aerospace engineering, 91
Affirmative action, 4
Aging, 190
Agricultural
biochemistry and nutrition (see Nutritional Sciences),
Economics, 95
Education, 97
Education, Master of, 70
engineering, 307
Experiment Station, 47
Agriculture, 98
Agronomy and plant genetics (see Plant Sciences)
A la Board (see All Aboard)
All Aboard, 56
American Indian Studies, 100
Anatomy, 101
Anesthesiology, 227
Animal Disease Diagnostic Service, 44
Animal nutrition, 103
Animal Physiology, 102
Animal Sciences, 103, 253
Anthropology, 104
Application for admission, 58
Application for degree candidacy, fees, 55
Applied Mathematics, 109
Applied Research in Anthropology, Bureau of, 45
Appointments, graduate, 62-63
Arabic, 258, 262
Arboretum, Boyce Thompson Southwest, 45
Archaeology, 104, 134
Architecture, 111
landscape, 296
Master of, 69
Master of Landscape, 72
Area development, 181
Arid Lands Resource Sciences, 112
Arid Lands Studies, Office of, 50
Arizona
Board of Regents, 14
Center for Educational Evaluation and Measurement, 44
Center for Educational Research and Development, 44
Cooperative Fishery Research Unit, 44
Cooperative National Park Resources Study Unit, 44
Cooperative Wildlife Research Unit, 44
Historical Society, 54
Medical Center Library, 53
Poison and Drug Information Center, 45
Remote Sensing Center, 45
Research Laboratories, 45
State Museum, 45
Arizona-Sonora Desert Museum, 54
Art, 112
Master of Fine Arts, major in, 71
Art collections, 53, 113
education, 116
galleries, 53, 113
history, 115
museum, 53, 113
Arts, Master of, 68
Assistance, financial, 62-63
Assistantships and associateships, 62
Astronomy, 117
Astrophysics, 117
Atmospheric chemistry, 118
electricity, 118
radiation, 118
Sciences 118
Physics, Institute of, 48
Auditing courses, 62
Averaging of grades, 61
Awards, 63
Bacteriology, 234
Baritone, 245
Bassoon, 245
Bilingual/bicultural education, 150
Biochemistry, 120
agricultural (see Nutritional Sciences)
INDEX

Biological sciences, 122

Biology
  cellular, 239, 234
ecology, 143
evolutionary, 143
general, 143
microbiology, 234
  molecular, 239, 234

Biomedical Engineering, 164

Board and room, 56
Board of Regents, 14

Botany, 143

Boyce Thompson Southwestern Arboretum, 45

Bureau of
  Applied Research in Anthropology, 45
  Geology and Mineral Technology, 46

Business Administration, 122
  Master of, 69

Business and Career Education, 123

Business education, 123

Business research, 46

Calendar, 11-13

Candidacy for advanced degrees, 59, 80, 83, 85

Cap and gown purchasing fees, 56

Case Studies, 89

Cello, 245

Cellular and developmental biology
  (See Molecular and Cellular Biology)

Center
  Computer, 51
  Health Sciences, Library, 53
  Latin American Area, 205
  Optical Sciences, 50
  Southwest, 50
  Space Imagery, 277
  Water Resources Research, 54

Center for
  Creative Photography, 46
  Study of Higher Education, 46, 193

Change-of-schedule fee, 55

Chemical Engineering, 124

Chemistry, 126

Child development and
  family relations, 172, 173

China, 258, 259

Chinese, 259

Chorus, 244

Civil Engineering and
  Engineering Mechanics, 129

Clarinet, 245

Classics, 134

Classification of courses
  (numbering system), 87-90

Climatology, 118

Clinical engineering, 164

Clinical pharmacokinetics laboratory, 50

Clothing, textiles, and interior design, 172, 174

Colleges, list of, 8

Colloquiums, 88

Combined media, 112

Committee on Graduate Study, 15

Community college personnel, majors for, 66

Community medicine, 229

Composition, 242, 244
  doctoral major, 86, 241
  master's degree major, 73

Computer center, 51

Computer engineering, 156

Computer Science, 135

Conducting, doctoral major, 86, 241

Consumer studies, 172, 175
  and home management, 172-176

Contents, 5

Continuing Education, 46

Cooperating organizations, 54

Cooperative Extension Service, 46

Cooperative Fishery Research Unit, 44

Cooperative National Park Unit, 44

Cooperative Wildlife Research Unit, 44

Correspondence
  directions for, 7
courses, 60, 88

Council, Graduate, 15

Counseling and Guidance, 137

Counseling, student, 56

Courses
  additional, 87
  auditing, 62
  cancellation, 87
  classification,
    (numbering system) 87
    foreign language, 88
  graduate, defined, 59, 87
  house-numbered, 88
  individual studies, 89-90
  prerequisite, 87
  repetition of, 88
  semester, 87
television, 49, 59, 88

withdrawal from, 60
  year-long, 87

Creative Photography, Center for, 46

Creative writing, (see also English)
  Master of Fine Arts, major in, 71

Credit
  for unclassified (not graduate) students, 59
general prerequisites for, 59

graduate, defined, 59

graduate, for seniors, 59

residence, 79, 81-82, 84
  transfer, 60

Criminal justice administration, 214

Curricular change, 87

Dairy science, 103

Dance, 140

Deans, list of, 14

Degree candidacy, 43, 59, 80, 83, 85

Degree candidacy fee, 55

Degrees
  doctor's, 79-86
  graduate (list), 64-66
  master's, 67-75
  second master's, 68
  specialist, 76-78

Dendrochronology, 184

Dendrohydrology, 184

Departments and courses of instruction, 87

Design, interior, 172, 174

Dietetics, 250

Dining service, 56

Dissertation, 80-81, 83, 85
  in absentia, 62
  microfilm fee, 56, 80, 83, 85
processing fee, 56, 80, 83, 85
publication, 80, 83, 85
registration for, 90
Disabled student services, 56
Distributive education, 123
Division of
  Economic and Business Research, 46
  Media and Instructional Services, 47
Divisions
  academic, 8
  Continuing Education, 46
Doctor of
  Education, 81
  Musical Arts, 83
  Philosophy, 79
Doctoral degrees, major fields, 65
Dormitories, 56
Drama, 140
  acting-directing option, 72
  design-technical production option, 72
  Master of Fine Arts major in, 71
Dropping a course, 60
Ecology and Evolutionary Biology, 143
Economic and Business Research, 46
Economic geography, 184
Economics, 146
  Agricultural, 95
  mineral, 237
Education, 149
  administration, 150
  Agricultural, 97
  bilingual/bicultural, 150
  Business and Career, 123
  Center for the Study of Higher Education, 193
  Continuing, 46
  Counseling and Guidance, 137
  distributive, 123
  Doctor of, 81
  Elementary education, 160
  extension, 87, 173
  foundations of, 150
  health, 192
  Higher Education, 193
  Home Economics, 172, 175
  Library Science, 208
  Master of, 70
  music, 74, 86
  Reading, 290
  Secondary, 301
  Special, 312
  Specialist in, 76
Educational administration, 150
Educational Foundations and Administration, 150
Educational media, 160, 301
Educational Psychology, 153
Educational Specialist, 76
Electrical and Computer Engineering, 156
Electrical engineering, 156
Elementary Education, 160
Energy engineering, 246
Energy systems engineering, 164
Engineering 163
  aerospace, 91
  agricultural, 307
  biomedical, 164
  Chemical, 124
  civil, 129, 130
  clinical, 164
  electrical, 156
  Electrical and Computer, 156
  energy, 246
  energy systems, 164
  environmental, 164
  Experiment Station, 47
  geological, 236, 237
  industrial, 321
  library, 52
  Materials Science and, 220
  mechanical, 91
  mechanics, 129, 133
  mining, 236, 238
  nuclear, 246
  Soils, Water, and, 307
  systems, 321
  Engineering Experiment Station, 47
  English, 164
  as a foreign language, test of, 58
  as a second language, 165
  education, 164
Enrollment
  Maximum, 61
  Minimum, 61
Entomology, 167
Entrance requirements, 57
Environment and Behavior, 169
Environmental engineering, 164
Research Laboratory, 47
Equal opportunity, 4
Ethnology, 104
Examinations
  final, 60, 68, 77, 81, 83, 85
  Graduate Record, 58
  other, 81, 86
  preliminary, 80, 82, 85
  qualifying, 76, 79, 82, 84
Expenses and fees, 55
  for assistanship, 56, 62
  for summer session, 62
Exercise and Sport Sciences, 170
Experiment Stations
  Agricultural, 43
  Engineering, 47
Explanatory notes, 87
Extension Service, Cooperative, 46

Facilities and services, 43
Faculty, 17-42
Family and Consumer Resources, 172
Family and Community Medicine, 228
Family economics (see Home Economics Education/Consumer Studies)
Family housing, 56
Family relations, 172, 173
Fees, 55
  Fees, assistanship, 56, 62
  Fellowships, 63
Fields of study, 64-66
Final examinations, 60, 68, 77, 81, 83, 85
Finance, 176
Financial and Real Estate, 176
Financial aid, 62-63
Fine Arts, Master of, 71
Fisheries science (see *Wildlife and Fisheries Science*).
Fishery Research Unit, 44
Flute, 245
Food science, 250
Foreign language examination fee, 55
Foreign language option, 67
Foreign language requirement, 80, 82, 85
Foreign students
  admission, 57
  English requirement, 58
  insurance, 58
  language examination fee, 55
  language requirement, 58
  Test of English as a Foreign Language, 58
Forest-watershed resources, 298
Foundations of education, 150
French and Italian, 178
French horn, 245
Full-time student status, 61
General biology (see *Ecology and Evolutionary Biology*).
General information, 43
General prerequisites for major graduate credit, 59
General regulations, 57
General requirements
  doctoral degrees, 79
  master’s degrees, 67
  specialist degrees, 76
Genetics, 180
Genetics, plant, 282
Geochemistry, 184
Geography and Regional Development, 181
Geological engineering, 236, 237
Geology, 184
Geology and Mineral Technology, Bureau of, 46
Geology, economic, 184
Geology, planetary, 184
Geophysics, 184
Geosciences, 184
German, 188
Gerontology, 190
Government (see *Political Science*).
Government agencies, 55
Grace H. Flandrau Planetarium, 47
Grade-point average, 61
Grades
  averaging, 61
  grading system, 60
  incomplete, 61
  minimum averages required, 61
  pass-fail option, 61
  removal of incomplete, 61
  scholarship requirements, 61
  special, 60
  withdrawal, 60
Grading system, 60
Graduate
  appointments, scholarships, and financial aids, 82
College address, 4
Council, 15
credit
  for seniors, 59
  for unclassified (not graduate) students, 59
  general prerequisites for, 59
  other courses, 59
  regular, 61
  transfer of, 60
degrees, 64-66
Library School, 208
majors, 64-66
recitals, 90
Record Examination, 58
status, 57
Study, Committee on, 15-16
study in summer session, 62
tuition scholarships, 63
Grants, 63
Greek, 134
Guidance and counseling, 137
Guidance services, student, 56
Guide to abbreviations, 9-10
Guide to symbols, 88
Guitar, 245
Gynecology, 230
Harp, 245
Harpsichord, 245
Health education, 192
Health-Related Professions, 191
Health Sciences Center Library, 53
Health services administration, 214
Hearing sciences, 315
Hebrew, 262
Higher Education, 193
  Center for the Study of, 193
Hindi, 260
Historical Society, Arizona, 54
History, 196
History and Philosophy of Science, 200
Holidays, 11-13
Home Economics, (see also *Family and Consumer Resources*).
Education, Master of, 69
Education/Consumer Studies, 175
Home Economics Education, 69, 175
  Master of, 69
Honor and awards, 63
Hoods, purchasing fee, 56
Horn, 245
Horticulture, 282
Hospital pharmacy, 269
House-numbered courses, 88
Housing facilities, 58
Human
  Development Laboratory, 47
  resource management/organizational behavior, 215
  services administration, 214
Hydrology and Water Resources, 200

In absentia, degrees, 62
Incompletes, 61
Independent study, 89
Indian Studies, American, 100
India-Pakistan, 260
Individual studies, 89
Industrial engineering, 321
Information, general, 43
Institute of Atmospheric Physics, 48
Instruction, courses of, 87-324
Instructional staff, 17
Insurance for foreign students, 58
Interdisciplinary Programs, 203
Interior design, 174
Internal medicine, 229
International special students, 57
Internships, 89
legislative, 89
Italian (see French and Italian)
Japan, 261
Japanese, 261
Jeffrey M. Golding Clinical Research Unit, 48
Journalism, 204
Judaic studies, 262
Karl Eller Center for the Study of the Private Market Economy, 48
Key to symbols, 88
Kitt Peak Observatory, 51
Laboratory
Clinical Pharmacokinetics, 50
Lunar and Planetary, 48
of Tree-Ring Research, 48
Landscape Architecture, 296
Master of, 72
Language requirements, foreign, 80, 82, 85
Languages
classical, 134
Eastern, 258
examination fee, 55
French, 178
Indian, 260
Italian, 179
Oriental, 258
Portuguese, 312
Romance, 300
Russian, 300
Slavic, 300
Spanish, 310
Latin, 134
Latin American Area Center, 205
Latin American Studies, 205
Law, 206
Law library, 52
Legislative internships, 89
Librarians, 208
Libraries, 52
Architecture, 53
Center for Creative Photography, 46
Health Sciences Center, 53
Law, 52
Library Science Collection, 52
Main, 52
Music Collection, 52
Science-Engineering, 52
University, 52-53
Library School, Graduate, 208
Library Science, 208
Master of, 72
Library science collection, 52
Linguistics, 211
Loans, student, 63
Lunar and Planetary Laboratory, 48
Main library, 52
Major fields
for doctoral degrees, 65
for master's degrees, 64
for specialist degrees, 65
Major professor, 67
Major subjects, 64-65
Management and Policy, 213
Management Information Systems, 217
Marketing, 219
Married student housing, 56
Master of
Accounting, 68
Agricultural Education, 69
Architecture, 69
Arts, 68
Business Administration, 69
Education, 70
Fine Arts, 71
Home Economics Education, 69
Landscape Architecture, 72
Library Science, 72
Music, 73
Public Administration, 74
Science, 68
Teaching, 75
Master's Degree Study Program, 67
Master's degrees
degrees offered, 64
final examination, 68
foreign language option, 67
general requirements, 67
major fields, 64
major professor, 67
publication of thesis, 68
second degree, 68
study program, 67
thesis, 67
time limitation, 67
Master's Report, registration for, 89
Materials Science and Engineering, 220
Mathematics, 222
Applied, 109
Maximum enrollment, 61, 63
Maximum enrollment, assistantships, 63
Meals, 56
Mechanical engineering, 91
Media
combined, 112
educational, 160, 301
Medical Center library, 53
Medical microbiology (see Microbiology and Immunology)
Medical technology, 192
Medicine, 227
Medicine, interdisciplinary, 227
Medieval Studies, 233
Metallurgical engineering (see Materials Science and Engineering)
Metallurgy (see Materials Science and Engineering)
Meteorology, 118
Microcampus, 49
Microbiology, and Immunology, 234
Specialist in, 78
Middle East, 262
Mineral museum, 49
Mineral economics, 237
Mineral engineering, 238
Mineralogy, 184
Minimum enrollment (see Supplementary Registration)
Mining and Geological Engineering, 236
Mining engineering, 238
Minor subjects, 79, 82, 84
Molecular and Cellular Biology, 239
Molecular biology, 239, 240
Molecular and medical microbiology (see Microbiology and Immunology)
Museums
Arizona State, 45
art, 53
Museum of Northern Arizona, 54
state, 45
Arizona Historical Society, 54
Music, 241
collection, 52
education, 74, 86
fees, 55
Master of, 73
theory, 74, 241
Musical Arts, Doctor of, 83
Musicology, 241
Master's degree major, 74
National Park Resources, 44
Natural resource recreation, 301
Natural resources, 295-300
Near East, Ancient, 258, 262, 263
Neurology, 229
Nonresident students, tuition, 55
Northern Arizona Museum, 54
Nuclear and Energy Engineering, 246
Nuclear reactor, 49
Numbering system, 87
Nursing, 248
Specialist in, 77
Nutrition and Food Science, 250
Nutrition and dietetics, 250
Nutritional Sciences, 253
Oboe, 245
Observatories
Kitt Peak, 51
Multiple-Mirror Telescope, 51
Steward, 50
Obstetrics-Gynecology, 230
Occupational Safety and Health, 193
Office of Arid Lands Studies, 50
Office of Interdisciplinary Programs, 203
Officers of the University, 14
Operations management, 215
Optical Sciences, 255
Optical Sciences Center, 50
Ophthalmology, 230
Organ, 245
Oriental Studies, 258
Other courses for graduate credit, 59
Other examinations, 81, 86
Pakistan, 260
Paleoenvironmental studies, 185
Paleontology, 185
Pass-fail, 61
Pathology, 230
Payment of fees, 55
Pediatrics, 231
Percussion instruments, 245
Performance, music, doctoral major, 86
Master of Music, major in, 73
Persian, 262
Petrology, 184
Pharmaceutical chemistry, 264
Pharmaceutical Sciences, 264
Pharmaceutics, 264
Pharmacognosy, 264
Pharmacokinetics laboratory, 50
Pharmacology, 265
Pharmacology and Toxicology, 266-268
Pharmacy Practice, 269
Philosophy, 270
Philosophy, Doctor of, 79
Philosophy of Law, 270
Philosophy of Science, 200, 270
Photography, Center for Creative, 46
Physical Education (see Exercise and Sport Sciences)
Physics, 272
Atmospheric, Institute of, 48
plasma, 277
Physiology, 275
Animal, 102
Piano, 244
Planetary geology, 184
laboratory, 48
Sciences, 277
Planning, 279
Plant Pathology, 280
Plant Protection, 281
Plant Sciences, 282
Plasma physics, 277
Policy and planning, 216
Political Science, 283
Portuguese, (see Spanish and Portuguese)
Poultry science, 103
Practicums, 89
Preceptorships, 89
Presession, 13
Press, University, 53
Preliminary examination, 80, 82, 85
Processing fee, thesis or dissertation, 55
Programs of study
for doctoral degrees, 79-86
for master's degrees, 67-75
for specialist degrees, 76-78
Proseminars, 89
Psychiatry, 231
Psychology, 287
   Educational, 153
Public Administration
   Master of, 74
Public management, 216
Public policy, planning and administration
   (see Management and Policy)
Publication of dissertation, 80, 83, 85
Publication of thesis, 68
Qualifying examination, 76, 78, 79, 82, 84
Quaternary-paleoenvironmental studies, 185
Radiology, 232
Range management, 297
Range resources, 297
Reactor, nuclear, 49
Reading, 290
Real estate, 176
Recitals, 90
Recreation, natural resource, 301
Regents, Board of, 14
Regional development, 181
Registration
   fees, 55
   late fee, 55
   maximum units, 61
   minimum units, 61
   no-credit, 62
   pass-fail, 61
   supplementary, 61
Regular graduate credit courses, 59
Regular graduate status, 57
Regulations, general, 57
Rehabilitation, 292
Religious observance and practice,
   accommodation of, 43
Religious observance and practice, 43
Remote Sensing, 294
Removal of incomplete, 61
Renewable Natural Resources, 295
Renewable natural resources studies, 296
Repetition of courses, 88
Requirements
   admission, 57
   for doctoral degrees, 79-88
   for master's degrees, 67-75
   for specialist degrees, 76-78
   scholarship, 62-63
Research
   assistantships, 62
   faculty, 17
   registration for, 89
Residence halls, 56
Residence requirements, 79, 81, 84
Romance Languages, 300
Room and board, 55, 56
fees for, 55-56
Russian and Slavic Languages, 300
Ruth E. Golding Clinical Pharmacokinetics
   Laboratory, 50
Sanskrit (see Classics)
Saxophone, 245
Scholarship requirements, 61
Scholarships and financial aids, 62-63
Science, Master of, 68
Science-Engineering Library, 52
Second master's degree, 68
Secondary Education, 301
Seminars, 89
Seniors, graduate credit for, 59
Services and facilities, 43
Single student housing, 56
Single-parent family housing, 56
Slavic languages, 300
Sociology, 304
Soil and water science, 308
Soils, Water and Engineering, 307
Southwest Center, 50
Southwest Institute for Research
   on Women, 50
Southwestern Research Station, 55, 143
Southwest studies, 309
Space Imagery Center, 277
Spanish and Portuguese, 310
Special Education, 312
Special grades, 60
Specialist degrees, major fields, 65
Specialist in
   Education, 76
   Microbiology, 78
   Nursing, 77
   Speech and Hearing Clinic, 56
   Speech and Hearing Sciences, 315
   Speech Communication, 318
   Statistics, 320
Status
   full-time, 61
   graduate, 57
   Steward Observatory, 50
Stratigraphy, 185
String bass, 245
Student
   American Indian adviser, 56
   counseling, 56
   disabled services program, 56
   foreign adviser, 56
   health services, 56
   housing, 56
   loans, 63
   services, 56
   Speech and Hearing Clinic, 56
   status, full-time, 61
   University Placement Service, 56
Studio art, 113
Summer session, 62
   admission, 62
   calendar, 13
   Guadalajara, 62
   expenses, 62
   presession, 13
   Supplementary registration, 61
   Surgery, 232
   Symbols, key to, 88
   Systems and Industrial Engineering, 321
   Systems engineering, 321
Table of contents, 5
   Teaching, Master of, 75
   Teaching and research faculty, 17
   Teaching assistantships, 62
   Teaching experience, 82
   Tectonics, 184
   Television courses, 49, 88
   Test of English as a Foreign Language, 58
Textiles, 174
Thesis,
in absentia, 62
processing fee, 55
publication of, 68
registration for, 90
Time limitations
doctoral degrees, 79, 82, 84
Educational Specialist, 76
master's degrees, 67
Toxicology, 267
Traineeships, 63
Transcript fee, 55
Transfer
of graduate credit, 60
Tree-Ring Research Laboratory, 48
Triga nuclear reactor, 49
Trombone, 245
Trumpet, 245
Tuba, 245
Tuition, 55
assistantships, 62-63
nonresident, 55-56
scholarships, graduate, 63
Unclassified graduate status, 57
Unclassified students, graduate credit for, 57
United States government agencies, 55
Units
maximum allowed, 61, 63
minimum enrollment, 61, 63
University
administration, 14
Analytical Center, 51

Computer Center, 51
dining service, 56
libraries, 52
observatories, 50, 117, 277
of Arizona Museum of Art, 53
of Arizona Press, 53
Urban planning (see Planning)
Urdu, 260

Veterinary Science, 323
Vocational education, 123, 292
Voice, 245
Viola, violin, 245

Water resources administration, 200, 202
Water Resources Research Center, 54
Watershed hydrology, 295
Watershed management, 298
Wildlife and fisheries science, 299
Wildlife ecology (see wildlife
and fisheries science)
Wildlife, fisheries, and
recreation resources, 299
Wildlife research unit, 44
Wind instruments, 245
Withdrawal
from courses, 60
grades, 60
Workshops, 89

Zoology (see Molecular and
Cellular Biology; Ecology and
Evolutionary Biology)
Guide to Buildings

56  Administration
88  Administration Annex
49  Aeronautical Engineering Building
39  Aerospace and Mechanical Engineering Laboratories
52  Agriculture
64  Agricultural Sciences
31  Anthropology
83  Apache Residence Hall
7  Architecture
9  Arid Lands Information Building
Arizona Bureau of Geology and Mineral Technology (See Arid Lands Information Building and Mines and Metallurgy)
30  Arizona Health Sciences Center
College of Medicine
Medical Library
Clinical Sciences
University Hospital
37  Arizona Residence Hall
85  Arizona Stadium
31  Arizona State Museum
2  Art Building
25  Art Department Graduate Studios
34  Auditorium
60  Babcock Building
89  Baseball Stadium
Basic Sciences (See Arizona Health Sciences Center)
70  Biological Sciences East
55  Biological Sciences West
21  Business and Public Administration
6  Center for Creative Photography
27  Center for English as a Second Language
63  Chemistry
20  Civil Engineering
Clinical Sciences (See Arizona Health Sciences Center)
35  Cochise Residence Hall
10  Coconino Residence Hall
College of Medicine (See Arizona Health Sciences Center)
26  Computer Center
24  Comstock House
23  Coronado Residence Hall
41  Douglass Building
3  Drama Building and Theater
87  East Stadium Residence Hall
33  Economics and Business Administration
61  Education
42  Electrical Engineering Laboratories
40  Engineering
1  Fine Arts Center and Annex
18  Family Practice Center
32  Geology
11  Gila Residence Hall
80  Homer Lodge
51  Graduate Library School
78  Graham Residence Hall
78  Greenlee Residence Hall
14  Harvill Classroom Building
58  Herring Hall
53  Home Economics
80  Hopi Lodge
29  Huachuca Residence Hall
66  Human Development Preschool
19  Instructional Services Building
15  International House
29  Kaibab Residence Hall
13  Law
46  Selim M. Franklin Building
77  Library
4  Manzanita Residence Hall
16  Maricopa Residence Hall
71  Mathematics
86  McKale Memorial Center
Mechanical Engineering (See Aerospace and Mechanical Engineering)
74  Men's Gymnasium
65  Microbiology
32  Mines and Metallurgy
62  Modern Languages
4  Mohave Residence Hall
2  Museum of Art
5  Music
87  Navajo Residence Hall
57  Nugent Alumni Building
48  Nursing
43  Old Main
84  Optical Sciences Center
79  Papago Lodge
36  Park Student Center
47  Pharmacy
82  Physical Education
75  Physical Resources
59  Physics and Atmospheric Sciences
12  Pima Residence Hall
87  Pinal Residence Hall
76  Planetarium
38  Poetry Center
68  Psychology
72  Purchasing and Stores
83  Santa Cruz Residence Hall
69  Science Library
8  Slonaker Alumni Building
44  Social Sciences
37  Sonora Residence Hall
46  South Residence Hall
81  Space Sciences
28  Speech Building
67  Steward Observatory
73  Student Health Center
50  Student Union Memorial Building
University Hospital (See Arizona Health Sciences Center)
54  Yavapai Residence Hall
22  Yuma Residence Hall