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.”
The University of Arizona Record (USPS 650-800)

VOL. LXXVI NO. 3 June, 1983

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 acquaint himself or herself with all regulations, to remain currently informed throughout his or her college career, 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 Department of Admissions and Records 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 is an EEO/AA Employer and does not discriminate on the basis of sex, age, race, religion, color, national origin, Vietnam Era Veterans' status, or handicapping conditions in its admissions, employment and educational programs or activities, and is required by Title IX of the Education Amendments of 1972 and the regulations adopted pursuant thereto in Title VII of the Civil Rights Act of 1964 and Section 504 of the Rehabilitation Act of 1973 not to discriminate in such manner. The requirement not to discriminate in educational programs and activities extends to employment therein and admission thereto. Inquiries concerning the application of said regulations to this university may be referred to Dr. Celestino Fernandez, Assistant Vice President for Affirmative Action, Administration 501, phone (602) 621-3081; or to the Director of the Office of Civil Rights of the U.S. Department of Education. 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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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 department for further information on departmental course offerings, degree programs, graduate assistantships, and tuition and academic scholarships.
Executive 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 Scholarships and Financial Aids for information about loans, college work-study programs, and other forms of financial assistance.
Director of Placement Service for information on part-time employment, teaching positions.
Manager of Student Housing for information on living accommodations.
Registrar concerning transcripts.
ACADEMIC DIVISIONS OF THE UNIVERSITY

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

COLLEGE OF AGRICULTURE. School of Home Economics (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.

COLLEGE OF ARCHITECTURE

COLLEGE OF ARTS AND SCIENCES. School of Music. Departments of: Anthropology; Art; Astronomy; Atmospheric Sciences; Cellular and Developmental Biology; Chemistry; Classics; Computer Science; Drama; Ecology and Evolutionary Biology; English; French and Italian; General Biology; German; History; Journalism; Linguistics; Mathematics; Microbiology; Oriental Studies; Philosophy; Physics; Planetary Sciences; Political Science; Psychology; Radio-Television; Russian and Slavic Languages; Sociology; Spanish and Portuguese; Speech and Hearing Sciences; and Speech Communication.

COLLEGE OF BUSINESS AND PUBLIC ADMINISTRATION. Departments of: Accounting; Economics; Finance and Real Estate; Geography and Regional Development; Management; Management Information Systems; Marketing; Public Policy, Planning and Administration.

COLLEGE OF EARTH SCIENCES. Departments of: Geosciences; Hydrology and Water Resources.

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; Nuclear and Energy Engineering; Systems and Industrial Engineering.

COLLEGE OF LAW

COLLEGE OF MEDICINE. Departments of: Anatomy; Anesthesiology; Family and Community Medicine; Internal Medicine; Molecular and Medical Microbiology; Neurology; Obstetrics-Gynecology; Ophthalmology; Pathology; Pediatrics; Pharmacology; Physiology; Psychiatry; Radiology; Surgery.

COLLEGE OF MINES. Departments of: Chemical Engineering; Metallurgical 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; Genetics; Materials Engineering; Medieval Studies; Nutritional Sciences; Optical Sciences; Pharmacology and Toxicology; Plant Protection; Romance Languages.

GENERAL DEPARTMENTS. Biochemistry; Physical Education; Statistics. School of Health-Related Professions; School of Military Science and Aerospace Studies

GENERAL COMMITTEES. American Indian Studies; Applied Mathematics; Biomedical Engineering; Black Studies; Business Administration; Gerontology; History and Philosophy of Science; Humanities; Latin American Studies; Religious Studies; Remote Sensing; Toxicology; Women’s Studies.
CONTINUING EDUCATION. Daytime and Evening Classes on Campus; Community Services; Conferences and Short Courses; Correspondence Course Offerings; Elder-hostel Programs; Opportunities for Women Programs; Specialized Clientele Programs; Special Interest Courses; Extension Courses and Degree Programs.

THE UNIVERSITY LIBRARIES
ABBREVIATION GUIDE

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

a.e. agricultural economics
a.ed. agricultural education
a.m.e. aerospace and mechanical engineering
a.ph. animal physiology
acct. accounting
ad.s. addiction studies
agri. agriculture
A.In.s. American Indian studies
an.s. animal sciences
anat. anatomy
anes. anesthesiology
anth. anthropology
appl. applied mathematics
ar.l. arid lands resource sciences
arch. architecture
astr. astronomy
atmo. atmospheric sciences
b.ed. business administration
b.c.ed. business and career education
bioc. biochemistry
Bl.s. Black studies
c.e. civil engineering
c.sc. computer science
c.d.f.r. child development and family relations
cell. cellular and developmental biology
c.he. chemical engineering
chem. chemistry
clas. classics
coun. counseling and guidance
c.s. consumer studies
c.t. clothing and textiles
dram. drama
e.e.e. electrical and computer engineering
e.m. engineering mechanics
ecol. ecology and evolutionary biology
econ. economics
ed.p. educational psychology
ed.f.a. educational foundations and administration
elem. elementary education
Eng. English
ento. entomology
f.c.m. family and community medicine
fin. finance and real estate
Fren. French
g.en. geological engineering
g.bio. general biology
gene. genetics
geog. geography and regional development
geos. geosciences
Ger. German
gero. gerontology
h.ec. home economics
h.ed. higher education
h.e.e. home economics education
hist. history
hth. health education
honr. honors
h.p.sc. history and philosophy of science
h.r.p. health-related professions
hum. humanities
hydr. hydrology
I.d. interior design
ids. interdisciplinary
I.med. internal medicine
ital. Italian
jour. journalism
l.ar. landscape architecture
L.A.s. Latin American studies
li.s. library science
ling. linguistics
M.A.s. Mexican American studies
math. mathematics
med. medicine (interdepartmental)
med.t. medical technology
met. metallurgical engineering
mgmt. management
micr. microbiology
m.l.s. management information systems
ml.g. marketing
ml.m. mineral sciences
ml.mic. molecular and medical microbiology
mn.e. mining engineering
mn.ec. mineral economics
mus. music
n.f.s. nutrition and food science
neur. neurology
n.r.r. natural resource recreation
n.u.e. nuclear and energy engineering
nurs. nursing
n.u.sc. nutritional sciences
ob.g. obstetrics and gynecology
oph. ophthalmology
opti. optical sciences
Or.s. Oriental studies
o.s.h. occupational safety and health
path. pathobiology
pcol. pharmacology and toxicology
ped. pediatrics
phcl. pharmacology (College of Medicine)
ph.ed. physical education
phil. philosophy
ph.pr. pharmacy practice
ph.sc. pharmaceutical sciences
phys. physics
pl.p. plant pathology
pl.s. plant sciences
pol. political science
Port. Portuguese
p.p.p.a. public policy, planning and administration
psio. physiology
psyc. psychology
psyl. psychiatry
pty.s. planetary sciences
R.lg. Romance languages
ra.m. range management
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>radi.</td>
<td>radiology</td>
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<tr>
<td>rdng.</td>
<td>reading</td>
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<tr>
<td>reli.</td>
<td>religious studies</td>
</tr>
<tr>
<td>rhab.</td>
<td>rehabilitation</td>
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<tr>
<td>r.n.r.</td>
<td>renewable natural resources</td>
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<tr>
<td>r.t.v.</td>
<td>radio-television</td>
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<tr>
<td>Russ.</td>
<td>Russian</td>
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<tr>
<td>s.ed.</td>
<td>secondary education</td>
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<tr>
<td>s.i.e.</td>
<td>systems and industrial engineering</td>
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<tr>
<td>soc.</td>
<td>sociology</td>
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<tr>
<td>sp.c.</td>
<td>speech communication</td>
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<td>sp.h.</td>
<td>speech and hearing sciences</td>
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<td>Span.</td>
<td>Spanish</td>
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<td>spec.</td>
<td>special education</td>
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<td>stat.</td>
<td>statistics</td>
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<tr>
<td>surg.</td>
<td>surgery</td>
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<tr>
<td>sw.c.</td>
<td>southwest studies</td>
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<tr>
<td>s.w.e.</td>
<td>soils, water and engineering</td>
</tr>
<tr>
<td>tox.</td>
<td>toxicology</td>
</tr>
<tr>
<td>u.pl.</td>
<td>urban planning</td>
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<tr>
<td>v.sc.</td>
<td>veterinary science</td>
</tr>
<tr>
<td>w.t.sc.</td>
<td>wildlife and fisheries science</td>
</tr>
<tr>
<td>w.s.</td>
<td>women's studies</td>
</tr>
<tr>
<td>w.r.a.</td>
<td>water resources administration</td>
</tr>
<tr>
<td>ws.m.</td>
<td>watershed management</td>
</tr>
</tbody>
</table>
GRADUATE CALENDAR

First Semester

1983-84                  1984-85
Deadline for complete applications for admission      July 18, M        July 23, M
Degrees awarded as of this date for students         Aug. 11, Th       Aug. 16, Th
    completing requirements at close of summer session Aug. 14, Su       Aug. 19, Su
Residence halls open                                  Aug. 17-19, W-F   Aug. 22-24, W-F
Registration                                           Aug. 22, M        Aug. 27, M
Classes begin                                         Aug. 29, M        Sept. 4, M
Deadline for petitions for graduate credit           Aug. 29, M        Sept. 4, Tu
Last day to register for credit, to add              Sept. 5, M        Sept. 3, M
    courses, and to change from no
    credit to credit                      
Labor Day - no classes                                Oct. 21, F        Oct. 26, F
Last day to file Master’s Degree Study Program       Oct. 28, F        Nov. 2, F
    for completion in December
Last day to drop with deletion of course from record  Nov. 11, F        Nov. 12, M
Records close for midsemester scholarship report      Nov. 24-27        Nov. 22-25
Last day for doctoral students to file                Nov. 30, W        Nov. 30, F
    Doctoral Degree Study Program for
    completion in May 1984, May 1985
Last day to drop courses and to change                Dec. 7, W          Dec. 12, W
    from credit to no credit
Veterans’ Day - no classes                            Dec. 9, F          Dec. 14, F
Thanksgiving recess                                    Dec. 13, M         Dec. 17, M
Last day to file Report on Master’s Final Examination  Dec. 16, F        Dec. 21, F
    for December completion (thesis, if any, must have
    preliminary approval by Graduate College after
    final examination)
Class and laboratory sessions end                    Dec. 29, Th        Dec. 27, Th
Semester examinations begin                           Dec. 30, F        Dec. 28, F
Last day to submit approved, library-ready copies of  Dec. 31, Sa        Dec. 31, M
    thesis for December completion
Semester examinations end                             Dec. 9, F          Dec. 14, F
Last day to take doctoral final oral                  Jan. 9-11, M-W    Jan. 14-16, M-W
    examination for December completion           Jan. 12, Th        Jan. 17, Th
Last day to submit library-ready copies of            Jan. 21, Th        Jan. 20, Th
    dissertation for December completion
Degrees awarded as of this date for students          Jan. 19, Th        Jan. 24, Th
    completing requirements
    at close of first semester

Second Semester

1983-84                  1984-85
Deadline for complete applications for admission      Dec. 9, F          Dec. 14, F
Registration                                           Jan. 9-11, M-W    Jan. 14-16, M-W
Classes begin                                         Jan. 12, Th        Jan. 17, Th
Deadline for petition for graduate credit             Jan. 21, Th        Jan. 20, Th
Last day to register for credit,                      Jan. 19, Th        Jan. 24, Th
    to add courses, and to change
    from no credit to credit
Last day for doctoral preliminary examination for    Jan. 16, M         Jan. 21, M
    May completion
Last day to file Application for Candidacy for May completion of doctoral requirements
Last day to file Master's Degree Study Program for completion in May
Last day to drop with deletion of course from record
Records close for midterm scholarship report
La Fiesta de los Vaqueros - no classes
Spring recess
Last day to file Master's Degree Study Program for summer completion
Last day to drop courses and to change from credit to no credit
Last day to file report on Master's Final Examination for May completion (thesis, if any, must have preliminary approval by Graduate College after final examination)
Last day to take doctoral final oral examinations for May completion
Last day to submit approved, library-ready copies of dissertation for May completion
Last day to submit approved, library-ready copies of thesis for May completion
Class and laboratory sessions end
Semester examinations begin
Semester examinations end
Commencement
Centennial Year Commencement

Summer Sessions

Presession
Registration
Presession classes begin
Holiday - no classes
Last day of classes and final examination day

First Summer Session
Registration
First summer session begin
Holiday - no classes
Last day of classes and final examination day

Second Summer Session
Registration
Second summer session begin
Last day to file report on Master's Final Examination for August completion (thesis, if any, must have preliminary approval by Graduate College after final examination)
Last day to take doctoral final oral examination for August completion
Last day to submit library-ready copies of dissertation for August completion
Last day of classes and final examination day

1984
Registration
Presession classes begin: May 14-15, M-Tu
Holiday - no classes: May 28, M
Last day of classes and final examination day: June 2, Sa

1985
Registration
Presession classes begin: May 20-21, M-Tu
Holiday - no classes: May 27, M
Last day of classes and final examination day: June 8, Sa

Jan. 16, M Jan. 22, T
Jan. 30, M Jan. 28, M
Feb. 8, W Feb. 13, W
Feb. 24, F Mar. 1, F
Mar. 1, Th Feb. 28, Th
Mar. 10-18 Mar. 16-24

Mar. 23, F Mar. 29, F
Mar. 28, W Apr. 3, W

Apr. 16, M Apr. 22, M
Apr. 16, M Apr. 26, M
Apr. 20, F Apr. 26, F
Apr. 30, M May 6, M
May 2, W May 8, M
May 4, F May 10, F
May 11, F May 17, F
May 12, Sa May 18, Sa

Registration
First Summer Session
Registration
First summer session begin: June 8, F
Holiday - no classes: June 10, M
Last day of classes and final examination day: July 4, Th

Second Summer Session
Registration
Second summer session begin: July 12, Th
Last day to file report on Master's Final Examination for August completion (thesis, if any, must have preliminary approval by Graduate College after final examination)
Last day to take doctoral final oral examination for August completion
Last day to submit library-ready copies of dissertation for August completion
Last day of classes and final examination day

1984
July 3, F July 12, F
July 16, M July 15, M

1985
July 23, M July 22, M
Aug. 14, T Aug. 12, M
Aug. 15, W* Aug. 14, W

Aug. 15, W Aug. 14, W
Arizona Board of Regents

EX OFFICIO

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

APPOINTED

VADA MANAGER, Assistant Secretary ................................................ May, 1983
S. THOMAS CHANDLER, LL.B., Assistant Treasurer .............................. January, 1984
WILLIAM G. PAYNE, M.D. ............................................................. January, 1984
ESTHER N. CAPIN, M.Ed., Treasurer ................................................ January, 1986
DONALD PITT, J.D. .............................................................................. January, 1986
TIO A. TACHIAS ................................................................................... January, 1988
WILLIAM P. REILLY, President .......................................................... January, 1988
DONALD G. SHROPSHIRE, B.S. ......................................................... January, 1990
A. J. PFISTER, LL.B. ............................................................................. January, 1990
University Administration

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

ADMINISTRATIVE OFFICERS

HENRY KOFFLER (1982) .................................................. President of the University
RICHARD ANDERSON HARVILL (1934) .................................. President Emeritus of the University
ALBERT BRUCE WEAVER (1958) ........................................ Executive Vice President
GARY M. MUNSINGER (1963) ........................................... Senior Vice President for Resources
LEE B. JONES (1964) ...................................................... Vice President for Research and Dean of the Graduate College
RICHARD M. EDWARDS (1959) ............................................ Vice President for Student Relations
ROBERT A. PETERSON (1978) ............................................ Vice President for Administrative Services
SHERWOOD E. CARR (1954) ............................................. Treasurer and Contracting Officer

GRADUATE COLLEGE OFFICERS

LEE B. JONES (1964) ...................................................... Vice President for Research and Dean of the Graduate College
HERBERT DAWSON RHOADES (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
HUGH EDWARD LAIRD, II (1974) ...................................... Associate Dean of the Graduate College

DEANS

BARTLEY P. CARDON (1980) ............................................. Dean of the College of Agriculture
JACK R. COLE (1957) .................................................... Dean of the College of Pharmacy
F. PENDLETON GAINES (1959) .......................................... Dean of Administration
RICHARD HUGO GALLAGHER (1978) .................................. Dean of the College of Engineering
RONALD GOURLY (1978) .................................................. Dean of the College of Architecture
ROGER C. HENDERSON (1977) .......................................... Dean of the College of Law
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
HUGH ODISHAW (1972) .................................................. Dean of the College of Earth Sciences
F. ROBERT PAULSEN (1964) ............................................. Dean of the College of Education
KENNETH R. SMITH (1980) ............................................. Dean of the College of Business and Public Administration
GLADYS ELAINE SORENSEN (1958) .................................... Dean of the College of Nursing
ROBERT STANLEY SVOB (1942-44; 1946) ......................... Dean of Students
DAVID LAWRENCE WINDSOR (1945) ................................. Dean of Admissions and Records

GRADUATE COUNCIL

H. Vasken Aposhian ......................................................... Professor of Cellular and Developmental Biology
Richard F. Cullee .......................................................... Professor of Speech and Hearing Sciences
George H. Davis ......................................................... Associate Professor of Geosciences
William G. Dever ....................................................... Professor of Oriental Studies
David A. Gay ............................................................. Associate Professor of Mathematics
Joseph F. Gross ......................................................... Professor of Chemical Engineering
David J. Hartshorne ..................................................... Professor of Nutrition and Food Science
Clay A. Hawkins ......................................................... Professor of Finance and Real Estate
Lee B. Jones .............................................................. Vice President for Research and Dean of the Graduate College, Chairman
Hugh Edward Laird, II .................................................. Associate Professor of Pharmacology and Toxicology
Larry L. Leslie ....................................................... Professor of Higher Education
Beverly A. McCord .................................................... Professor of Nursing
Glen I. Nicholson .......................................................... Professor of Educational Psychology
Robert McLean Quinn ..................................................... Professor of Art
John S. Ramberg ............................................................ Professor of Systems and Industrial Engineering
William A. Remmers ........................................................ Professor of Pharmacology
Douglas G. Stuart ............................................................ Professor of Physiology
Jane H. Underwood ......................................................... Professor of Anthropology
Jean E. Weber ................................................................. Professor of Statistics
Mary C. Wetzel ................................................................. Professor of Psychology

COMMITTEE ON GRADUATE STUDY

Ronald E. Allen (1985)* ........................................... Assistant Professor of Animal Sciences
Wilbur S. Ames (1983) .................................................... Professor of Reading
Jay B. Angelvine, Jr. (1985) .............................................. Professor of Anatomy
H. Vasken Aposthian (1983) .............................................. Professor of Cellular and Developmental Biology and of Pharmacology
Peter H. Bartels (1984) ..................................................... Professor of Microbiology
Koste A. Belchert (1985) .................................................... Professor of Optical Sciences
William P. Bemis (1983) ................................................. Associate Professor of Music
Marlene Bence (1986) ...................................................... Clinical Associate Professor of Rehabilitation
Bryant Benson (1985) ...................................................... Professor of Anatomy
Walter H. Birkby (1985) .................................................... Physical Anthropologist
Michael E. Bonine (1984) ................................................ Associate Professor of Oriental Studies
Klaus Brendel (1986) ....................................................... Professor of Pharmacology
Stanley K. Bricker (1984) ................................................. Associate Professor of Renewable Natural Resources
William H. Brown (1985) ................................................. Professor of Animal Sciences
George A. Brubaker (1983) .............................................. Associate Professor of History
Robert F. Butler (1986) .................................................... Professor of Philosophy
Robert L. Caldwell (1985) .............................................. Professor of English
J. Douglas Canfield (1984) ............................................. Associate Professor of Psychology
Wayne R. Carroll (1986) ................................................. Associate Professor of History
Roger de Laix (1984) ....................................................... Professor of Sociology
Beverly Duncan (1983) ..................................................... Associate Professor of Finance and Real Estate
John T. Emery (1986) ....................................................... Professor of Music
B. Roy Frieden (1984) ..................................................... Professor of Optical Sciences
Jibamita Ganguly (1986) .................................................. Associate Professor of Geosciences
Juan R. Garcia (1985) ..................................................... Associate Professor of History
Lloyd W. Gay (1983) ....................................................... Professor of Watershed Management
Juan J. Gilbert (1983) .................................................... Professor of Spanish and Portuguese
Andrew M. Goldner (1985) ............................................ Associate Professor of Physiology
Loyal A. Gryting (1983) .................................................. Professor of French and Italian
Lanin A. Gyurko (1986) .................................................. Professor of Spanish and Portuguese
David M. Hendricks (1983) .......................................... Associate Professor of Soils, Water and Engineering
Bill W. Hillman (1986) ..................................................... Professor of Counseling and Guidance
Ada Sue Hinshaw (1986) .................................................. Professor of Nursing
Robert T. Huber (1985) .................................................. Professor of Physics and Microbiology
Philip C. Keller (1986) .................................................. Professor of Entomology
Rein Kilkson (1985) ....................................................... Professor of Psychology
James E. King (1985) ..................................................... Professor of Nutrition and Food Science
Henry W. Kircher (1984) ................................................ Associate Professor of Anatomy
Clayton W. Kischer (1984) ............................................. Associate Professor of Speech Communication
Frank K. La Ban (1986) .................................................. Associate Professor of Elementary Education
Carol F. Larson (1983) .................................................. Associate Professor of Counseling and Guidance
Philip J. Lauver (1986) .................................................. Associate Professor of Management Information Systems
Averell M. Law (1986) .................................................. Associate Professor of Anatomy
Albert V. LeBouton (1984) ............................................ Associate Professor of Mathematics
Louise Chin Lin (1983) .................................................. Associate Professor of Elementary Education
Richard L. Lopez, Jr. (1984) ........................................... Assistant Professor of Mathematics
David Lovelock (1983) .................................................... Professor of Civil Engineering
David O. Lucas (1983) .................................................. Associate Professor of Molecular and Medical Microbiology
Peter B. Machinist (1983) .............................................. Assistant Professor of Oriental Studies
Thomas Maddock, III (1984) ......................................... Professor of Hydrology and Water Resources
Allan J. Mahlick (1983) .................................................. Associate Professor of Civil Engineering and Engineering Mechanics
Arwind S. Marathy (1985) ............................................. Professor of Optical Sciences
Robert H. Marshall (1985) .................................................. Professor of Economics
Bruce E. McGraw (1986) .................................................. Professor of Art
Spencer McWilliams (1984) .................................................. Assistant Professor of Psychology
Marcello Medina, Jr. (1985) ............................................. Assistant Professor of Educational Foundations and Administration
Richard E. Michod (1984) .................................................. Associate Professor of Ecology and Evolutionary Biology
Jerry L. Miller (1984) .................................................. Associate Professor of Sociology
Iraj J. Misaghi (1983) .................................................. Associate Professor of Plant Pathology
Mary-Ellen Morbeck (1984) ........................................... Associate Professor of Anthropology
Lawrence O. Nelson (1986) ............................................... Professor of Educational Administration
Richard Newcomb (1984) .............................................. Professor of Mining and Geological Engineering
Betty J. Newlon (1986) .................................................. Associate Professor of Counseling and Guidance
James E. Officer (1984) .................................................. Professor of Anthropology
Glen S. Pate (1985) .................................................. Associate Professor of Secondary Education
Stanley Pogrow (1985) ............................................... Associate Professor of Educational Foundations and Administration
Roy G. Post (1984) .................................................. Professor of Nuclear and Energy Engineering
Srinivasan Raghavan (1986) ........................................... Assistant Professor of Metallurgical Engineering
Donald E. Ray (1986) .................................................. Professor of Animal Sciences
J. Jefferson Reid (1985) ............................................. Associate Professor of Anthropology
Cecil Robinson (1983) .................................................. Professor of English
Jon Rodiek (1985) .......................................................... Associate Professor of Landscape Architecture
Rosemary A. Rosser (1984) ........................................... Associate Professor of Educational Psychology
Kathryn R. E. Russell (1985) ........................................ Associate Professor of Physical Education
Macario Saldate, IV (1984) ........................................... Associate Professor of Educational Foundations and Administration
F. Raymond Salemme (1983) .......................................... Associate Professor of Biochemistry
Michael Schaller (1983) .......................................... Associate Professor of History
Michael B. Schiffer (1983) ........................................... Professor of Anthropology
Alice E. Schlegel (1985) .................................................. Professor of English
Herbert N. Schniedau (1986) ......................................... Professor of Atmospheric Sciences
Richard M. Scholland (1984) ......................................... Professor of Systems and Industrial Engineering
Donald G. Schultz (1985) .................................................. Professor of Aerospace and Mechanical Engineering
Farhang Shadman (1986) ............................................. Associate Professor of Chemical Engineering
Ralph L. Shelton (1985) .................................................. Professor of Speech and Hearing Sciences
Richard Shoemaker (1984) ........................................ Associate Professor of Optical Sciences
James T. Sinski (1983) .................................................. Associate Professor of Microbiology and of Molecular and Medical Microbiology
Norman S. Smith (1986) .................................................. Professor of Wildlife Ecology
Gerald H. Stott (1986) .................................................. Professor of Animal Sciences
Malur Sundareshan (1986) .......................................... Associate Professor of Electrical Engineering
Patricia Van Metre (1986) .......................................... Associate Professor of Speech Communication
G. Krishna Vemulapalli (1985) ........................................... Associate Professor of Chemistry
David J. A. Vieck (1985) ........................................... Associate Professor of Ecology and Evolutionary Biology
Thomas J. Volgy (1983) .................................................. Associate Professor of Political Science
Joseph J. Vullermin (1986) ........................................... Professor of Physics
Robert A. Westbrook (1986) ......................................... Associate Professor of Marketing
Jack H. Wilmore (1985) .................................................. Professor of Physical Education
Robert H. Wortman (1984) ........................................ Associate Professor of Civil Engineering

*Term expiration.
Teaching and Research Faculty

Aamodt, Agnes Marie, Professor of Nursing
Abbott, Doris, Lecturer in Nursing
Abbott, James LeRoy, Assistant Research Scientist in Soils, Water and Engineering
Abraham, Kitty L.G., Assistant Professor of Home Economics
Abrams, Herbert Kerman, Professor of Family and Community Medicine
Adamec, Ludwig Warran, Professor of Oriental Studies
Adams, William Grant, Associate Professor of Art
Afonso, Dyanne Delmendo, Associate Professor of Nursing
Agee, Barbara Joan, Lecturer in Nursing
Agnyeray, Gerard, Lecturer in French and Italian
Aiken, Susan Hardy, Associate Professor of English
Akoljian, Adrian, Professor of Linguistics
Albanese, Charles Anthony, Professor of Architecture
Alberts, David S., Professor of Internal Medicine
Alcorn, Esther E., Lecturer in Family and Community Medicine
Alcorn, Stanley Marcus, Professor of Plant Pathology
Alejandri, Lawrence Massud, Professor of Educational Psychology
Alepa, Francis P., Professor of Internal Medicine
Alexander, E. Russell, Professor of Pediatrics
Allbrand, Lucinda, Assistant Professor of Addiction Studies
Allen, Adela, Associate Professor of Reading
Allen, Frank Warren, Assistant Professor of Management Information Systems
Allen, Hugh D., Professor of Pediatrics
Allen, Janice Rae, Assistant Professor of Nursing
Allen, Jerry Dean, Assistant Professor of Drama
Allen, Paul Malcolm, Professor of Secondary Education
Allen, R. Van, Professor of Elementary Education
Allen, Ronald Eugene, Assistant Professor of Animal Sciences and of Nutrition and Food Science
Allen, Ross Marvin, Professor of Plant Pathology
Allen, Rupert Clyde, Jr., Professor of Spanish and Portuguese
Allen, Ruth Amelia, Professor Emerita of Home Economics
Altmann, Ellen, Professor of Library Science
Altschul, D. Robert, Associate Professor of Geography and Regional Development
Ames, Wilbur Stanley, Professor of Reading
Amundson, Gary Robert, Lecturer in Animal Sciences
Amy, Gary Lee, Assistant Professor of Civil Engineering and Engineering Mechanics
Anastacio, Geraldine Diane, Assistant Professor of Pharmacy Practice
Anderson, Patricia Lee, Associate Professor of Reading
Anderson, Karen Sue, Assistant Professor of History
Anderson, Robert M., Associate Professor of Surgery
Anderson, Roger A., Professor of Aerospace and Mechanical Engineering
Anderson, Ruth Marjorie, Lecturer Emerita in Speech and Hearing Sciences
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
Angivine, Jay Bernard, Jr., Professor of Anatomy
Angus, Robert Chauncey, Professor of Agricultural Economics
Anthony, James Raymond, Professor of Music
Anthony, John Williams, Professor of Geosciences
Antley, Elizabeth Martin, Professor of Reading
Antrim, William H., Lecturer in Business and Career Education
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Aquilano, Nicholas, Associate Professor of Management
Ares, Charles E., Professor of Law
Arztizabal, Silvio Antonio, Associate Professor of Radiology
Arkowitz, Harold S., Associate Professor of Psychology
Arkowitz, Sidney W., Lecturer in Psychiatry
Armstrong, Edward Paul, Assistant Professor of Pharmacy Practice
Armstrong, Neal Russell, Associate Professor of Chemistry
Arnold, Jack Robert, Lecturer in Pharmacy Practice
Ascher, Mark L., Associate Professor of Law
Attarian, Peter J., Associate Professor of Family and Community Medicine
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Atwood, Harry W., Associate Professor of Radio and Television Film Production
Atwood, Janet R., Professor of Nursing
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Avery, Arthur, Associate Professor of Home Economics
Axline, Stanton G., Associate Professor of Internal Medicine
Babcock, Barbara Anne, Associate Professor of English
Babcock, Clarence L., Professor Emeritus of Optical Sciences
Babich, George, Assistant Professor of Secondary Education
Baccarav, Dosio C., Associate Professor of Electrical Engineering
Bagnara, Joseph Thomas, Professor of General Biology
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Bailey, Don Clifford, Professor of Oriental Studies
Bailey, William Edward, Lecturer in Speech Communication
Baker, Boyd Byron, Associate Professor of Physical Education
Baker, Gregory R., Associate Professor of Mathematics and of Aerospace and Mechanical Engineering
Baker, Robert George, Lecturer in Anthropology
Baker, Robert Lewis, Associate Professor of Systems and Industrial Engineering
Baker, Victor R., Professor of Geosciences
Balch, Philip, Associate Professor of Psychology
Balma, Thomas F., Associate Professor of Aerospace and Mechanical Engineering
Ballets, Paul Anthony, Professor of Military Science
Bamford, Colin Rory, Assistant Professor of Neurology
Banner, William Jr., Assistant Professor of Pediatrics and of Pharmacology
Bannister, Bryant, Professor of Dendrochronology
Barbee, John Charles, Assistant Professor of Military Science
Barbee, Robert, Professor of Internal Medicine
Barber, William Dale, Lecturer in Anatomy
Barefoot, Russell Morris, Professor of Accounting
Barfield, Michael, Professor of Chemistry
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Barkley, David Lane, Assistant Professor of Agricultural Economics
Barnes, William Donald, Professor of Secondary Education
Barreca, Frank R., Professor 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
Barrow, Leo Lebron, Professor of Spanish and Portuguese
Bartels, Paul George, Professor of Plant Sciences
Bartels, Peter Hans, Professor of Microbiology and of Optical Sciences
Barth, Jacqueline, Lecturer in Nursing
Bartlett, Neil Riley, Professor of Psychology
Bashkin, Stanley, Professor of Physics
Basso, Ellen Becker, Associate Professor of Anthropology
Bastron, R. Dennis, Associate Professor of Anesthesiology
Battman, Herman E., Professor Emeritus of History
Bates, Robert Brown, Professor of Chemistry
Battan, Louis Joseph, Professor of Atmospheric Sciences
Baur, Daniel Joseph, Assistant Professor of Military Science
Bauwens, Eleanor Eustice, Professor of Nursing
Bechtel, Robert B., Professor of Psychology
Beck, Jean, Professor Emeritus of German
Beck, Phillip O., Assistant Professor of Management Information Systems
Becker, Stewart, Professor Emeritus of Electrical Engineering
Beckers, Jacques Maurice, Director of the Multiple Mirror Telescope Observatory
Beeker, Ruth Ann, Associate Professor of Elementary Education
Beigel, Allan, Professor of Psychiatry
Belcher, Koste Alexander, Associate Professor of Music
Bell, Jan R., Curator of Collections in the Arizona State Museum
Bemis, William Putnam, Professor of Plant Sciences
Bennett, George A., Professor Emeritus of Pharmaceutical Sciences
Bennett-Alder, Leon, Lecturer in Family and Community Medicine
Benson, Bryant, Professor of Anatomy
Benson, Clark Tabor, Professor of Mathematics
Bentley, John Boyd, Assistant Professor of Anesthesiology
Bergen, John R., Professor of Educational Psychology
Bergesen, Albert James, Associate Professor of Sociology
Bergson, Isa Partsch, Associate Professor of Physical Education
Berk, Robert, Associate Professor of Library Science
Berkhout, Carl T., Assistant Professor of English
Berti, David Charles, Professor of Educational Psychology
Berengard, Peter, Director of the Museum of Art
Bernath, Peter Francis, Assistant Professor of Chemistry
Bernstein, Alan Edgar, Associate Professor of History
Bernstein, Gail Lee, Associate Professor of Oriental Studies
Bernstein, Harris, Professor of Molecular and Medical Microbiology
Berry, James Wesley, Professor of Nutrition and Food Science
Bessey, Paul Mack, Associate Professor of Plant Sciences
Beutler, Larry E., Professor of Psychiatry and Psychology
Bhattacharya, Rabindra Nath, Professor of Mathematics
Bickel, William Samuel, Professor of Physics
Bier, Milan, Professor of Engineering
Bierwag, Gerald O., Professor of Finance and Real Estate
Billings, Richard Bruce, Lecturer in Economics
Binkley, Anne L., Assistant Professor of Physical Education and Athletics
Birkby, Walter H., Physical Anthropologist and Lecturer in Anthropology
Bishop, Jerold, Associate Professor of Art
Bjelland, John Curtis, Assistant Professor of Radiology
Bjorhovde, Reidar, Professor of Civil Engineering
Black, William Charles, Assistant Professor of Marketing
Blanchard, James, Associate Professor of Pharmaceutical Sciences
Blask, David E. Assistant Professor of Anatomy
Blecha, Milo Kasal, Professor of Elementary Education
Bleck, Erich K., Associate Professor of Finance and Real Estate
Bleibtreu, Hermann Karl, Professor of Anthropology
Blett, Casey David, Professor of Anesthesiology
Blitzer, Leon, Professor of Physics
Block, Michael Kent, Associate Professor of Public Policy, Planning and Administration of Economics
Bloom, John, Assistant Professor of Internal Medicine
Bloom, John H., Professor Emeritus of Music
Bliss, Homer Earl, Associate Professor of Plant Pathology
Bluestein, Marlene, Assistant Professor of Internal Medicine
Boe, John Merle, Professor of Music
Boelts, Jackson Gustaf, Assistant Professor of Art
Bogart, Fred O., Professor Emeritus of Accounting
Boggis, Juanita Lou, Assistant Professor of Elementary Education
Boghosian, Harry Der, Associate Professor of Architecture
Bohn, Hinrich Lorenz, Professor of Soils, Water and Engineering
Bok, Bart Jan, Professor Emeritus of Astronomy
Bonine, Michael Edward, Associate Professor of Oriental Studies
Boone, Daniel R., Professor of Speech and Hearing Sciences and Surgery
Bootman, J. Lyle, Assistant Professor of Pharmacy Practice
Borhek, James Theodore, Associate Professor of Sociology
Boss, Candace S., Assistant Professor of Special Education
Bottacini, Manfred Ronald, Professor Emeritus of Aerospace and Mechanical Engineering
Bourjaily, Vance, Professor of English
Bourke, Don Phillippe, Associate Professor of Nutrition and Food Science and Biochemistry
Bowden, George Timothy, Assistant Professor of Radiology
Bowen, Don L., Professor of Public Administration
Bowen, Roger, Associate Professor of English
Bowen, Theodore, Professor of Physics and Radiology
Bowers, Raymond V., Professor Emeritus of Sociology
Bownds, John Marvin, Associate Professor of Mathematics
Boych, William Thomas, Assistant Professor of Pediatrics
Boyd, William E., Professor of Law
Boyd, Thomas Willard, Assistant Professor of Internal Medicine
Boyer, John Thomas, Professor of Internal Medicine
Boyle, Alice, McLaughlin, Professor Emerita of Plant Pathology
Boynton, William V., Associate Professor of Planetary Sciences
Bradley, John Michael, Associate Professor of Reading
Bradley, Michael Douglas, Associate Professor of Hydrology and Water Resources
Brand, Myles, Professor of Philosophy
Brannon, Patsy Marie, Assistant Professor of Nutrition and Food Science
Braun, Eldon John, Associate Professor of Physiology
Brendel, Klaus, Professor of Pharmacology
Brennan, James Michael, Assistant Professor of Military Science
Bressler, Rubin, Professor of Internal Medicine
Brewer, Willis Ralph, Professor of Pharmacy
Brick, Dean C., Assistant Professor of Ophthalmology
Brickler, Stanley Keith, Associate Professor of Renewable Natural Resources
Briggs, Maurice M., Professor Emeritus of Finance, Insurance and Real Estate
Briggs, Robert Eugene, Professor of Plant Sciences
Brillhart, John David, Professor of Mathematics
Britton, John R., Assistant Professor of Pediatrics
Bronson, Arturo, Assistant Professor of Metallurgical Engineering
Brooks, John, Professor Emeritus of Spanish and Portuguese
Broson, Henry Walter, Professor of Psychiatry
Browder, Robert Paul, Professor of History
Brown, Anita Dolores, Professor of Spanish and Portuguese
Brown, Burrell Roland, Jr., Professor of Anesthesiology
Brown, Claude Hilding, Professor Emeritus of Law
Brown, Edward Dietz, Professor of Elementary Education
Brown, Edward Guillen, Jr., Associate Professor of French and Italian
Brown, James Hemphill, Professor of Ecology and Evolutionary Biology
Brown, Stephanie Lee, Assistant Professor of Reading
Brown, William Hedrick, Professor of Animal Science
Browning, Samuel Roberts, Professor Emeritus of Systems Engineering
Browning, Timothy A., Lecturer in Speech Communication
Brubaker, George A., Associate Professor of History
Bryant, Donald Leon, Professor Emeritus of Geosciences
Bryson, Philip James, Professor of Economics
Buchanan, Allen Edward, Professor of Philosophy
Buchanan, Elizabeth, Associate Professor of Law
Buchhauser, Andrew W., Professor Emeritus of Music
Buckingham, Robert William, Associate Professor of Public Administration and of Family and Community Medicine
Buckman, Carl John, Professor Emeritus of Civil Engineering
Budd, Timothy Alan, Assistant Professor of Computer Science
Buehler, John Edward, Professor of Economics
Bull, William Benham, Professor of Geosciences
Buras, Nathan, Professor of Hydrology and Water Resources
Burke, Alan R., Associate Professor of English
Burke, James Joseph, Professor of Optical Sciences
Burke, Michael Francis, Associate Professor of Chemistry
Burkhart, Ford N., Associate Professor of Journalism
Burkhart, Leland, Professor Emeritus of Horticulture and Landscape Architecture
Burks, Thomas F., II, Professor of Pharmacology
Burns, Robert Alan, Lecturer in Religious Studies
Burroughs, Robert Clark, Professor of Drama
Burrows, Benjamin, Professor of Internal Medicine
Burton, Lloyd Edward, Professor of Addiction Studies and Pharmacy Practice
Bustamente, Sergio A., Associate Professor of Pediatrics and of Nursing
Butler, Henry Emerson, Jr., Professor of Educational Foundations and Administration
Butler, Robert Franklin, Associate Professor of Geosciences
Byerly, Henry Clement, Associate Professor of Philosophy
Byers, James Martin, Associate Professor of Pathology
Byrne, David Nesbitt, Assistant Professor of Entomology
Cable, Cecil Curtis, Jr., Professor of Agricultural Economics
Caldwell, William Alexander, Jr., Professor of Ecology and Evolutionary Biology
Caldwell, Mary Estill, Professor Emerita of Bacteriology and Pharmacology
Caldwell, Robert Lee, Professor of Philosophy
Caldwell, Roger Lee, Professor of Soils, Water and Engineering
Calkins, Jerry Milan, Assistant Professor of Anesthesiology
Call, Reginald Lessley, Associate Professor of Electrical Engineering
Calmes, Robert Edward, Professor of Educational Psychology
Campbell, Sammy C., Assistant Professor of Internal Medicine
Canfield, Hazel Gertrude, Lecturer in Nursing
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Cannon, Jerry A., Lecturer in Civil Engineering and Engineering Mechanics
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Capp, Michael Paul, Professor of Radiology
Capponi, Guido Antonio, Professor of French and Italian
Cardon, Bartley P., Professor of Agricultural Economics
Carille, Robert Nichols, Professor of Electrical Engineering
Carlson, Eric W., Assistant Professor of Public Administration
Carmody, Raymond F., Assistant Professor of Radiology
Carnes, Pack, Assistant Professor of German
Carpenter, Robert D., Professor of Public Administration
Carroll, Christopher F., Lecturer in English
Carroll, Rosalie Fay, Assistant Professor of Journalism
Carroll, Wayne Richard, Associate Professor of Psychology
Carson, Donald Winslow, Professor of Journalism
Carswell, Evelyn Medicus, Associate Professor of Elementary Education
Carter, Dean Edwin, Associate Professor of Pharmacology and Toxicology
Carter, Mary Arkley, Associate Professor of English
Carter, Paul A., Professor of History
Cetas, Thomas C., Assistant Professor of Radiology
Chaffant, James C., Professor of Special Education
Chamberlain, Charles T., Assistant Professor of Classics
Chambers, Frank McMin, Professor Emeritus of Romance Languages
Chambers, Robert H., Professor of Physics
Champagne, Francis Henry, Professor of Aerospace and Mechanical Engineering
Chan, Marie C., Assistant Professor of Oriental Studies
Chance, Helen Caroline, Associate Professor of Nursing
Chandola, Anoop Chandra, Professor of Oriental Studies
Chann, Abe, Associate Professor of Journalism
Chapman, Phillip Creighton, Associate Professor of Political Science
Chase, Richard Barth, Professor of Management
Cheema, Mohindar Singh, Professor of Mathematics
Chen, Chuan F., Professor of Aerospace and Mechanical Engineering
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Chester, S. Theodore, Assistant Professor of Renewable Natural Resources
Chew, Soo Hong, Assistant Professor of Economics
Chissell, Robert Breton, Professor of Veterinary Science
Chicotte, John Henry, Professor of Educational Foundations and Administration and of Anthropology
Chin, Lincoln, Professor of Pharmacology and Toxicology
Chisholm, David Hollister, Associate Professor of German
Chiu, Wah, Assistant Professor of Cellular and Developmental Biology
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Christensen, Harvey DevOn, Professor of Aerospace and Mechanical Engineering
Christensen, Oscar Carl, Jr., Professor of Counseling and Guidance
Christian, Charles Donald, Professor of Obstetrics and Gynecology
Christiansen, Harvey Duane, Associate Professor of Counseling and Guidance
Christianson, Jon Brian, Associate Professor of Public Policy, Planning and Administration and of Economics
Christie, William Morrison, Jr., Associate Professor of English
Christopherson, Victor Alden, Professor of Home Economics
Church, Edna Erickson, Professor Emerita of Music
Chvapil, Milo, Professor of Surgical Biology
Claridge, Roy Monroe, Assistant Dean of the College of Education
Clark, Donald Clayton, Professor of Secondary Education
Clark, Kenneth N., Associate Professor of Architecture
Clark, L. D., Professor of English
Clark, Robert Emmet, Professor Emeritus of Law
Clarke, James W., Professor of Political Science
Clay, James Ray, Professor of Mathematics
Clayton, J. Wesley, Jr., Professor of Pharmacology and Toxicology and of Microbiology
Cleland, Courtney Blair, Associate Professor of Sociology
Coan, Richard Walton, Professor of Psychology
Coates, Wayne Ewen, Associate Professor of Soils, Water and Engineering
Cochrane, Frederick Lewis, Assistant Professor of Nuclear Engineering
Cocke, William Johnstone, Associate Professor of Astronomy
Cockrum, Edmond L., Professor of Ecology and Evolutionary Biology
Cole, Jack Robert, Professor of Medicinal Chemistry
Coleman, Jules Leslie, Professor of Philosophy
Comer, George D., Professor of Family and Community Medicine and of Pediatrics
Conant, Howard Somers, Professor of Art
Coney, Peter J., Professor of Geosciences
Conley, Eugene Thomas, Professor Emeritus of Music
Connor, William Gordon, Associate Professor of Radiology and Electrical Engineering
Conover, Jerry Neil, Assistant Professor of Marketing
Conrad, Clifton Forbes, Associate Professor of Higher Education
Conrad, Kenneth Allen, Assistant Professor of Pharmacology and Internal Medicine
Consroe, Paul Francis, Professor of Pharmacology and Toxicology
Contractor, Dianeh N., Professor of Civil Engineering
Converlino, Victor A., Assistant Professor of Physical Education
Conway, William Edward, Associate Professor of Mathematics
Cook, Gary Dennis, Associate Professor of Music
Cook, Mary Jean, Associate Professor of English
Copeland, Jack Greene, III, Professor of Surgery
Cork, Randall Charles, Assistant Professor of Anesthesiology
Corrigan, James, Professor of Pediatrics and Lecturer in Internal Medicine
Corliss, Richard Carroll, Professor of Political Science
Cory, Dennis Charles, Associate Professor of Agricultural Economics
Cosart, William Primm, Associate Professor of Chemical Engineering
Cosgrove, Richard A., Associate Professor of History
Coulier, Pearl, Dean and Professor Emerita of Nursing
Cowherd, Stanley William, Professor of Surgery
Cowan, Joseph Lloyd, Professor of Philosophy
Cox, James C., Professor of Economics
Cox, Vivian Elaine Lewis, Associate Professor of Elementary Education
Crewell, Bennie Sue, Associate Professor of Medical Technology
Croft, Michael Fluyt, Associate Professor of Art
Cronin, Constance, Associate Professor of Anthropology
Crosswhite, Carol Diane, Curator of Zoology, Boyce Thompson Arboretum
Crosswhite, Frank Samuel, Curator of Botany, Boyce Thompson Arboretum
Crow, John Edward, Associate Professor of Political Science
Crowder, Larry Arnold, Professor of Entomology
Culbert, T. Patrick, Professor of Anthropology
Curlee, Richard Frederick, Professor of Speech and Hearing Sciences
Curtis, Richard Farisworth, Professor of Sociology
Cusano, Michael Anthony, Professor of Biochemistry
Cushing, Jim Michiel, Professor of Mathematics
DaDeppo, Donald A., Professor of Civil Engineering and Engineering Mechanics
Daemen, Jask J. K., Assistant Professor of Mining and Geological Engineering
Dahood, Roger, Associate Professor of English
Daidrup, Roger John, Professor of Counseling and Guidance
Darmon, Paul Edward, Professor of Geosciences
Daniel, Terry Clyde, Professor of Psychology and Renewable Natural Resources
Darniel, Paul Joseph, Professor Emeritus of Counseling and Guidance
Dantzer, William Hoyt, Professor of Physiology
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Davis, Donald Ross, Associate Professor of Hydrology and Water Resources
Davis, George Herbert, Associate Professor of Geosciences
Davis, Jack Emory, Professor of Romance Languages
Davis, James G., Associate Professor of Art
Davis, James Wayne, Associate Professor of Speech Communication
Davis, John Robert, Professor of Pathology
Davis, Mary Patricia, Lecturer in Nursing
Davis, Owen Kent, Assistant Professor of Geosciences
Davis, Russell Price, Associate Professor of General Biology
Davis, Stanley Nelson, Professor of Hydrology and Water Resources
Davis, Thomas P., Assistant Professor of Pharmacology
Dawson, George Albert, Professor of Atmospheric Sciences
Day, Arden Dexter, Professor of Plant Sciences
Day, Larry John, Professor of Music
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Dearborn, David Simon-Paul, Assistant Professor of Astronomy
Dermond, Murray, Lecturer in Psychology
DeCoutre, Pierre, Associate Professor of Health Education
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Deplaine, Walter Harold, Professor Emeritus of Economics
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DeJoria, Vine, Jr., Professor of Political Science
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Demarest, Jean-Jacques, Professor of French and Italian
Dennman, John Anthony, Associate Professor of Music
Dennison, Robert E., Professor of Plant Sciences
Denniston, Douglas Gilbert, Professor of Art
Denny, John L., Jr., Professor of Mathematics
Denny, William F., Professor of Internal Medicine
Denton, M. Bonner, Professor of Chemistry
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Dewalt, Evelyn Mae, Assistant Professor of Nursing
Dewhirst, Leonard Wesley, Professor of Veterinary Science
Dhahwai, Dan Singh, Associate Professor of Accounting
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Dickinson, Robert E., Professor Emeritus of Geography, Area Development and Urban Planning
Dickinson, William Richard, Professor of Geosciences
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Dillan, Robert Clarence, Lecturer in Mathematics
Dimm, Sarah M., Associate Professor of Educational Psychology
Dinnerstein, Leon, Professor of History
Dinnerstein, Myra, Chairperson, Committee on Women's Studies
Dixon, Harold Wesley, Jr., Associate Professor of Drama
Dobbs, Dan B., Professor of Law
Dopren, Albert Krubak, Professor of Plant Sciences
Dodge, Russell R., Assistant Professor of Internal Medicine and of Family and Community Medicine
Domino, George, Professor of Psychology
Donsahoe, Douglas J., Professor of Physics
Dorshoe, James, Professor of History
Doolan, Margaret Bailey, Associate Professor of Art
Doton, Jay Carnith, Professor of Mining and Geological Engineering
Dow, Phyllis L. Duggan, Lecturer in Nursing
Downer, Nancy Wueth, Assistant Professor of Biochemistry
Downey, Peter J., Assistant Professor of Computer Science
Downing, Theodore Edmond, Research Associate Professor of Anthropology
Downs, Deborah, Assistant Professor of Management Information Systems
Doxalter, Dennis Charles, Assistant Professor of Architecture
Doyal, Mary, Professor of Law
Drabicki, John Zbigniew, Associate Professor of Economics
Drach, George Wisse, Professor of Surgery
Drake, Michael Julian, Associate Professor of Planetary Sciences
Dray, Andre, Associate Professor of Pharmacology
Droegemueller, Lee Arthur, Associate Professor of Educational Foundations and Administration
Dryden, Edgar Alton, Professor of English
Duckles, Sue Piper, Assistant Professor of Pharmacology
Duckstein, Lucien, Professor of Systems and Industrial Engineering and of Hydrology and Water Resources
Dudley, Donald Goodnow, Jr., Professor of Electrical Engineering
Dübrner, Max, Professor of German
Dulles, John W. F., Professor of History
Duncan, Beverly, Professor of Sociology
Duncan, Burris Richard, Associate Professor of Pediatrics
Duncan, Otis Dudley, Professor of Sociology
Dunkel, Alexander, Associate Professor of Russian and Slavic Languages
Durie, Brian G. M., Professor of Internal Medicine
Dutt, Gordon Richard, Professor of Soils, Water and Engineering
Dutton, Vivian Frances, Associate Professor of Elementary Education
Dvorak, Robert William, Associate Professor of Architecture
Dworkin, Judith Marcia, Assistant Professor of Hydrology and Water Resources
Dye, Fred Arthur, Associate Professor of English
Dzoba, Robert B., Assistant Professor of Surgery
Earnest, David Lewis, Associate Professor of Internal Medicine
Eastoe, Christopher John, Assistant Professor of Geosciences
Eaton, Richard Maxwell, Associate Professor of Oriental Studies
Ebeltoft, Richard Allen, Lecturer in Architecture
Eckhardt, August G., Professor of Law
Edwards, John R., Assistant to the Executive Vice President
Edwards, Richard Modlin, Professor of Chemical Engineering
Ehsani, Mohammad R., Assistant Professor of Civil Engineering and Engineering Mechanics
Eich, Wayne Melvin, Lecturer in Management Information Systems
Eisner, Sigmund, Professor of English
Emery, John T., Associate Professor of Finance and Real Estate
Emrick, Roy M., Professor of Physics
Endrizzi, John Edwin, Professor of Plant Sciences
Enemark, John Henry, Professor of Chemistry
Enoka, Roger Maro, Assistant Professor of Physical Education
Enstoe, Wayne Edward, Associate Professor of Art
Enyeart, James L., Director of the Center for Creative Photography
Epperson, Gordon, Professor of Music
Erickson, Maynard Lindsey, Professor of Sociology
Erickson, Melvin Charles, Professor Emeritus of Health Education
Erickson, Richard L., Associate Professor of Counseling and Guidance
Ertings, Billie Rae, Professor of Music
Ervin, Elizabeth Zinn, Associate Professor of Music
Ervin, Thomas Rosa, Lecturer in Music
Escamilla, Manuel, Associate Professor of Elementary Education
Evans, Daniel Donald, Professor of Hydrology and Water Resources
Evans, Gilbert Edward, Associate Professor of Spanish and Portuguese
Evans, Robert Ronald, Associate Professor of Sociology
Evans, Walter Haskell, Professor Emeritus of Electrical Engineering and Atmospheric Sciences
Evers, Lawrence J., Associate Professor of English
Ewbank, Henry Lee, Professor of Speech Communication
Ewing, Reid Harris, Assistant Professor of Public Policy, Planning and Administration
Ewy, Gordon A., Professor of Internal Medicine
Fagan, Timothy Charles, Assistant Professor of Internal Medicine and of Pharmacology
Fahey, Shirley Nichols, Assistant Professor of Psychiatry
Fahey, Walter John, Professor of Electrical Engineering
Fain, Samuel S., Professor Emeritus of Music
Fairchild, Patricia Carlette, Associate Professor of Physical Education
Faith, Richard, Professor of Music
Falto, Charles Maurice, Professor of Physics
Fan, Chang-Yun, Professor of Physics
Fan, Paula, Assistant Professor of Music
Fangmeier, Delmar Dean, Professor of Soils, Water and Engineering
Faris, William, Professor of Mathematics
Farr, William Morris, Associate Professor of Nuclear and Energy Engineering
Fasse, William Roberts, Assistant Professor of Home Economics
Fazio, Steve, Professor of Plant Sciences
Fazzolare, Rocco Anthony, Associate Professor of Nuclear and Energy Engineering
Feaster, Carl Vance, Professor of Plant Sciences
Feinberg, Joel, Professor of Philosophy
Felix, Carlos A., Director of the Guadalupe Summer School
Feitham, Robert Dean, Professor of Chemistry
Fenster, Paul E., Assistant Professor of Internal Medicine
Ferdon, Edwin Nelson, Jr., Ethnomusicologist in the Arizona State Museum and Lecturer in Anthropology
Ferguson, Charles Wesley, Professor of Dentrochronology
Fernandez, Celestino, Assistant Professor of Sociology
Fernando, Quintus, Professor of Chemistry, Toxicology, and Forensic Sciences
Ferrall, John R., Professor of Music
26 TEACHING AND RESEARCH FACULTY

Ferrai, William R., Professor of Systems and Industrial Engineering
Ferris, Wayne Robert, Professor of Cellular and Developmental Biology
Ferry, Peggy Copple, Professor of Pediatrics and Neurology
Fielder, Peter Frederick, Professor of Watershed Management
Filiotti, Paul Chase, Professor of Mathematics
Filippone, William Lawrence, Associate Professor of Nuclear and Energy Engineering
Fillerup, Joseph McDonald, Professor of Elementary Education
Fink, Uwe, Associate Professor of Planetary Sciences
Fink, William H., Professor Emeritus of Economics
Finley, Paul R., Professor of Pathology
Fitch, Robert S., Professor of Agricultural Economics
Fischler, Ronald S., Assistant Professor of Family and Community Medicine and of Pediatrics
Fish, Paul R., Archeologist in the Arizona State Museum
Fisher, Thomas Gee, Lecturer in the Rehabilitation Center
Fisher, Warren Douglas, Professor of Plant Sciences
Fitch, John Richard, Associate Professor of Music
Fitch, Walter Stewart, Professor of Astronomy
Fitzsimmons, James Martin, Professor of Military Aerospace Studies
Fischka, Hermann, Professor of Mathematics
Flescher, Alan S., Professor of Surgery
Fleming, Margaret Brown, Associate Professor of English and Secondary Education
Flemming, Leslie Abel, Associate Professor of Oriental Studies
Flesa, Karl Walter, Associate Professor of Geosciences
Flegstein, Neil D., Assistant Professor of Sociology
Flint, Franklin Smith, Professor of Architecture
Fippo, Edwin B., Professor of Management
Fogel, Martin Mark, Professor of Watershed Management
Foltz, Jack O., Associate Professor of Accounting
Fordney, Diane Sharon, Associate Professor of Obstetrics and Gynecology
Forster, Leslie Stewart, Professor of Chemistry
Fortman, Marvin, Associate Professor of Management
Foster, Arland G., Professor Emeritus of Aerospace and Mechanical Engineering
Foster, Kenneth Earl, Assistant Research Professor in Arid Lands Studies
Foster, Robert E., Professor of Plant Sciences
Foster, Taylor William, III, Associate Professor of Accounting
Fowler, H. Bruce, Assistant Dean of the College of Fine Arts
Fox, Roger William, Professor of Agricultural Economics
Frank, Helmut J., Professor of Economics
Frank, Milton, Assistant Professor of Psychiatry
Franken, Peter Alden, Professor of Optical Sciences and Physics
Fraser, Christopher Warwick, Associate Professor of Computer Science
Freiser, Henry, Professor of Chemistry
Frevert, Richard Keller, Professor of Agricultural Engineering
Frieden, B. Roy, Professor of Optical Sciences
Fritts, Harold Clark, Professor of Dendrochronology
Froede, Richard Coe, Associate Professor of Pathology
Frost, Kenneth Raymond, Professor Emeritus of Soils, Water and Engineering
Fulginitti, Vincent Anthony, Professor of Pediatrics
Fuller, Dorothy Nadene, Lecturer in English
Fuller, Dorothy Van Arsdale, Professor Emerita of English
Fuller, Wallace Hamilton, Professor of Soils, Water and Engineering
Fung, Kee Yung, Assistant Professor of Aerospace and Mechanical Engineering
Furst, Emanuel F., Director of Biomedical Engineering
Gaddis, Charles William, Lecturer in General Biology
Gaines, Edwin Metcalfe, Associate Professor of History
Gaines, F. Pendleton, Professor of Educational Foundations and Administration
Galbraith, Frederick William, Professor Emeritus of Geology
Galgiani, John N., Assistant Professor of Internal Medicine
Gall, Eric Papineau, Associate Professor of Internal Medicine and of Surgery
Gall, Robert L., Associate Professor of Atmospheric Sciences
Gallagher, Richard Hugo, Professor of Civil Engineering
Gamal, Adel Sulaiman, Professor of Oriental Studies
Ganapati, Barry Dugglas, Associate Professor of Nuclear and Energy Engineering
Ganguly, Jibamitra, Associate Professor of Geosciences
Garcia, John Armando, Associate Professor of Political Science
Garcia, Jose Dolores, Jr., Professor of Physics
Garcia, Juan Ramon, Associate Professor of History
Gardner, Maria Evrand, Assistant Professor of Pharmacy Practice
Gardner, Ruth Marian B., Lecturer in English
Gardner, Wilford R., Professor of Soils, Water and Engineering
Garfield, Donald Kenneth, Assistant Professor of Art
Gaskell, Jack Donald, Professor of Optical Sciences
Gavrilak, Emil Stephen, Professor Emeritus of Secondary Education
Gay, David Andrew, Associate Professor of Mathematics
Gay, Lloyd Wesley, Professor of Watershed Management
Gegenheimer, Albert Frank, Professor Emeritus of English
Gehrels, Anton Marie J., Professor in the Lunar and Planetary Laboratory
Gendler, William George, Associate Professor of Electrical Engineering
Gerba, Charles P., Associate Professor of Nutrition and Food Science and of Microbiology
Gerber, Joseph Samuel, Associate Professor of Finance and Real Estate
Gerhardt, Paul Donald, Professor Emeritus of Entomology
Gerner, Eugene Willard, Associate Professor of Radiology
Gesell, John Leo, Jr., Lecturer in French and Italian
Getty, Harry Thomas, Professor Emeritus of Anthropology
Gibbs, Hyatt M., Professor of Optical Sciences
Gibson, Josephine Ruth, Associate Professor of Nursing
Gibson, Lay James, Professor of Geography and Regional Development
Gibson, Margaret Bohannan, Assistant Professor of Russian and Slavic Languages
Gibson, Ursula J., Assistant Professor of Optical Sciences
Giebner, Robert Carl, Professor of Architecture
Gifford, Gilbert L., Professor Emeritus of Economics
Gilbert, John J., Professor Emeritus of Spanish and Portuguese
Gilbertson, Robert Lee, Professor of Plant Pathology
Gill, Joseph, Professor Emeritus of Management
Gillen, Robert Lee, Assistant Professor of Range Management
Gillette, J. Michael, Associate Professor of Drama
Gilmore, Frances, Professor Emerita of English
Gimello, Robert M., Professor of Oriental Studies
Gipson, Rosemary P., Associate Professor of Drama
Glass, Charles Edwin, Associate Professor of Mining and Geological Engineering
Glass, Richard Steven, Associate Professor of Chemistry
Glasser, Lewis, Associate Professor of Pathology
Glatke, Theodore Joseph, Professor of Speech and Hearing Sciences and of Surgery
Godfrey, Donald George, Associate Professor of Radio-TV
Godwin, R. Kenneth, Associate Professor of Political Science
Goettnick, Jean Firmin, Lecturer in French and Italian
Goldberg, Stanley J., Professor of Pediatrics
Golden, Judith Green, Associate Professor of Art
Goldman, Steven, Associate Professor of Internal Medicine
Goldner, Andrew Michael, Associate Professor of Physiology
Goldstone, Jerry, Professor of Surgery
Goll, Darrel E., Professor of Nutrition and Food Science
Gomez, Rosendo A., Professor Emeritus of Government
Gonzalez, Roseann Duenas, Associate Professor of English
Goodman, Kenneth S., Professor of Elementary Education
Goodman, Seymour, Professor of Management Information Systems
Goodman, Yenta M., Professor of Elementary Education
Goodwin, Melvin H., Professor of Family and Community Medicine
Goodwin, Thomas Naudain, Lecturer in Continuing Education
Gore, Robert Wilson, Professor of Physiology
Gothberg, Helen M., Associate Professor of Library Science
Goudinoff, Peter Alexis, Lecturer in Political Science
Gould, Laurence M., Professor Emeritus of Geosciences
Gourley, Ronald, Professor of Architecture
Graham, Anna R., Assistant Professor of Pathology
Graham, Gordon Jackson, Professor of Agricultural Communications
Granger, Byrd Howell, Professor Emerita of English
Grant, Arthur Thomas, Professor of Higher Education
Grant, Robert Truman, Professor of Educational Foundations and Administration
Greeley, Andrew M., Professor of Sociology
Green, Ellery Culver, Professor of Architecture
Greenberg, Bernard R., Associate Professor of Internal Medicine
Greenberg, Jeff, Assistant Professor of Psychology
Greenberg, Richard P., Associate Professor of Surgery
Greene, Dennis Ivan, Associate Professor of German
Greene, Vernon L., Assistant Professor of Public Policy, Planning and Administration
Greenlee, Wilfred Martin, Professor of Mathematics
Greer, William Frank, Assistant Professor of Journalism
Gregg, Karl Curtiss, Lecturer in Spanish and Portuguese
Grimes, William Joseph, Associate Professor of Biochemistry
Griswold, Ralph E., Professor of Computer Science
Groemer, Helmut, Professor of Mathematics
Grogan, Thomas Malcolm, Assistant Professor of Pathology
Gross, Joseph Francis, Professor of Chemical Engineering
Grossman, Maurice K., Professor of Art
Grove, Larry Charles, Professor of Mathematics
Gruener, Raphael Peter, Professor of Physiology
Gruen, Janet, Lecturer in Nursing
Grutling, Loyal A. T., Professor of French and Italian
Guerrero, Adalberto Mendez, Lecturer in Spanish and Portuguese
Guilbert, John Moss, Professor of Geosciences
Guillo, Joseph D., Associate Professor of Educational Psychology
Guy, Donna Jay, Associate Professor of History
Guzauskas, Anthony Clement, Lecturer in Surgery
Gyurko, Latin Andrew, Professor of Spanish and Portuguese
Haber, Kai, Associate Professor of Radiology
Hadley, Mac Eugene, Professor of General Biology
Hagglund, Roger M., Assistant Professor of Russian and Slavic Languages
Hake, Jonathan C., Assistant Professor of Family and Community Medicine
Hale, William Harris, Professor of Animal Science
Hall, David John, Professor Emeritus of Civil Engineering
Hall, Donald Roots, Associate Professor of Political Science
Hall, Henry K., Professor of Chemistry
Hall, Jennifer Dean, Assistant Professor of Cellular and Developmental Biology
Hall, Thomas Leavitt, Professor Emeritus of Law
Hamara, Oma, Associate Professor of Mathematics
Hamberger, Joseph R., Assistant Professor Emeritus of Sociology
Hamblin, Robert Lee, Professor of Sociology
Hamroff, Stuart R., Assistant Professor of Anesthesiology
Hamilton, Douglas James, Professor of Electrical Engineering
Hamilton, Gordon E., Assistant Professor of Radio and Television Production
Hanlon, Keith Carl, Professor of Plant Sciences
Hanlon, Marie Padgett, Professor Emerita of English
Hansen, Ronald C., Assistant Professor of Internal Medicine and Pediatrics
Hanson, David Roy, Associate Professor of Computer Science
Hanson, Richard Thomas, Assistant Professor of Drama
Harclerode, Fred Fairley, Professor of Higher Education
Harnish, Robert Michael, Associate Professor of Philosophy and of Linguistics
Harris, DeVerle Porter, Professor of Mining and Geological Engineering
Harris, Robert Martin, Professor of General Biology
Harrison, Gail Grigsby, Associate Professor of Family and Community Medicine and of Nutrition and Food Science and of Pediatrics
Harrison, H. Robert, Assistant Professor of Pediatrics
Harraw, Edward J., Assistant Professor of Pathology
Harshbarger, John William, Professor Emeritus of Hydrology and Water Resources
Harshman, Gordon Adair, Associate Professor of Counseling and Guidance
Hartell, Ornie Michael, Professor of Music
Hartshorne, David J., Professor of Nutrition and Food Science and of Biochemistry
Harvill, Richard Anderson, Professor of Economics
Hasan, Ziaul, Assistant Professor of Physiology
Haskell, Jeffrey Robert, Assistant Professor of Music
Haskin, Donald Marcus, Professor Emeritus of Art
Hathorn, Scott, Jr., Professor of Agricultural Economics
Haugen, Edward B., Associate Professor of Aerospace and Mechanical Engineering
Haury, Emil Walter, Fred A. Riecker Distinguished Professor Emeritus of Anthropology
Hausenbauer, Charles Robert, Professor of Electrical Engineering
Hausser, Mark Robert, Associate Professor of Biochemistry
Havens, William Henry, Professor of Landscape Architecture
Hawes, Donald B., Professor Emeritus of Civil Engineering and Engineering Mechanics
Hawkins, Clark A., Professor of Finance and Real Estate
Hayden, Julian D., Research Associate Emeritus, Arizona State Museum
Haynes, Caleb Vance, Professor of Anthropology and Geosciences
Haynes, Catherine Ann, Assistant Professor of Nursing
Hazzard, Mary Ellen, Associate Professor of Nursing
Healey, William Charles, Professor of Special Education
Hebel, Susan J., Assistant Professor of Landscape Resources
Hecht, Melvin E., Professor of Geography and Regional Development
Heck, Gordon, Professor of Architecture
Heckelman, Donald George, Associate Professor of Economics
Hedtke, Charles Herman, Associate Professor of Oriental Studies
Heed, William Battles, Professor of Ecology and Evolutionary Biology
Hegland, Kenney F., Professor of Law
Heim, Carol A., Assistant Professor of Sociology
Heinrich, Juan Carlos, Assistant Professor of Aerospace and Mechanical Engineering
Heins, Marilyn Joan, Associate Professor of Pediatrics
Heidt, Carl Randall, Professor of Art
Heit, Richard C., Associate Professor of German
Henderson, Richard N., Professor of Anthropology
Henderson, Roger Caldwell, Professor of Law
Hendricks, David Marion, Associate Professor of Soils, Water and Engineering
Hendrickson, John Roscoe, Professor of Ecology and Evolutionary Biology
Hendrix, Mary J. C., Assistant Professor of Anatomy
Henry, Robert E., Associate Professor of Radiology
Herber, Bernard P., Professor of Economics
Heric, John Frederick, Associate Professor of Art
Herman, Benjamin Morris, Professor of Atmospheric Sciences
Herschler, Jonathan, Associate Professor of Ophthalmology
Hertz, Lewis, Associate Professor of Psychology
Ittelson, William H., Professor of Psychology
Hentosch, Herman, Professor of Spanish and Portuguese
Jablonski, David, Assistant Professor of Ecology and Evolutionary Biology
Jackson, Ernest Baker, Professor of Plant Sciences
Jacobs, Clinton Otto, Professor of Agricultural Education
Jacobs, Stephen F., Professor of Optical Sciences
Janik, Nina, Assistant Professor of Physical Education and Athletics
Janssen, Robert James, Associate Professor of Microbiology
Jellinek, Arthur J., Professor of Anthropology
Jenkins, Edgar William, Professor of Physics
Jensen, Gary Franklin, Associate Professor of Sociology
Jensen, Henning, Professor of Philosophy
Jensen, Merle Harold, Professor of Plant Sciences
Jensen, Richard Carl, Associate Professor of Classics
Jensen, Richard Grant, Professor of Biochemistry and Plant Sciences
Jernigan, Earl Wesley, Assistant Professor of Anthropology
Jeter, Wayburn Steward, Professor of Microbiology
Jimenez, Rudolf August, Professor of Civil Engineering and Engineering Mechanics
Jochums, Richard Marion, Jr., Associate Professor of Physical Education
Joens, Lynn A., Assistant Professor of Veterinary Science
Johnson, Bob Gene, Professor of Rehabilitation
Johnson, Borghild Eleanor, Professor Emerita of Home Economics
Johnson, David Gregory, Associate Professor of Internal Medicine and Pharmacology
Johnson, Henry Pickens, Jr., Professor Emeritus of Music
Johnson, Jack Donald, Associate Professor of Arid Lands
Johnson, James William, Associate Professor of Journalism
Johnson, Keith Marion, Associate Professor of Music
Johnson, Paul Christian, Professor of Physiology
Johnson, Peter Charles, Associate Professor of Pathology
Johnson, Ramona Mae, Assistant Professor of Nursing
Johnson, Robert K., Professor of Library Science
Johnson, Roy Andrew, Associate Professor of Music
Johnson, Vern R., Associate Professor of Electrical Engineering
Jokipii, Jack Randolph, Professor of Astronomy and Planetary Sciences
Jones, Christopher Kenneth, Assistant Professor of Mathematics
Jones, Harold Henry, Associate Professor of Art
Jones, James Fly, Associate Professor of Pediatrics
Jones, Lee Bennett, Professor of Chemistry
Jones, Roger Clyde, Professor of Electrical Engineering
Jones, Stephen E., Professor of Internal Medicine
Jones, Warren D., Professor of Landscape Architecture
Jordan, Gilbert L., Professor of Range Management
Jucius, Michael J., Professor Emeritus of Management
Just, Kurt W., Professor of Physics
Kaback, Keith R., Assistant Professor of Surgery
Kahn, Marvin W., Professor of Psychology
Kamel, Hussein Ahmed, Professor of Aerospace and Mechanical Engineering
Kashefi, Jean-Louis, Associate Professor of Music
Kassander, Arno Richard, Professor Emeritus of Atmospheric Sciences
Kaszniai, Alfred Wayne, Associate Professor of Psychiatry
Katterman, Frank Reinald Hugh, Professor of Plant Sciences
Katz, Barnett, Assistant Professor of Ophthalmology and Neurology
Katz, Murray Alan, Associate Professor of Internal Medicine
Kaufman, Ralph Claude, Professor Emeritus of Psychology
Kay, Arthur Murray, Associate Professor Emeritus of English
Kay, Margarita Artschwager, Professor of Nursing
Kearns, Jean Rulcy, Professor of Home Economics
Keating, Kenneth Lee, Professor of Metallurgical Engineering
Kecacoglu, Dimitri Basil, Professor of Aerospace and Mechanical Engineering
Keck, Konrad, Professor of Cellular and Developmental Biology
Keene, James Frederick, Associate Professor of Music
Keller, Philip Charles, Professor of Chemistry
Kelley, Alec Ervin, Professor of Chemistry
Kelley Lee McDowell, Lecturer in Microbiology
Kellner, Peggy Juliette, Associate Professor of Drama
Kellogg, Frederick, Associate Professor of History
Kelly, Anna Maria, Lecturer in French and Italian
Kellso, Maurice Mayum, Professor Emeritus of Agricultural Economics
Kellso, Paul, Professor Emeritus of Political Science
Kemmerer, Arthur Russel, Professor Emeritus of Agricultural Biochemistry
Kendall, Elizabeth L., Assistant Professor of Home Economics
Kennedy, Ruth Lee, Professor Emerita of Spanish
Kerst, Henry Conrad, Jr., Associate Professor of Political Science
Keppler, Carl Francis, Professor Emeritus of English
Kesecher, Edward J., Assistant Professor of Aerospace and Mechanical Engineering
Kerwin, William James, Professor of Electrical Engineering
Kessler, John Otto, Professor of Physics
Ketcham, Carl Huntington, Professor of English
Kettel, Louis John, Professor of Internal Medicine
Keyworth, Robert A., Professor of Drama
Klibler, Ruthann, Assistant Professor of Molecular and Medical Microbiology
Kidwell, Richard Alvin, Professor of Business and Career Education
Kidwell, Susan M., Assistant Professor of Geosciences
Kiefer, Frederick Paul, Jr., Associate Professor of English
Kieras, David E., Assistant Professor of Psychology
Kight, Mary Ann, Professor of Nutrition and Food Science
Klikson, Rein, Professor of Physics and Microbiology
Kim, Young C., Professor of Mining and Geological Engineering
King, Andrew Arthur, Professor of Speech Communication
King, David Austen, Professor of Renewable Natural Resources and Agricultural Economics
King, James E., Professor of Psychology
King, Patricia Ann, Assistant Professor of Nursing
King, Patricia Honwen, Lecturer in Accounting
King, Paul Hamilton, Professor of Civil Engineering and Engineering Mechanics
King, William Howard, Jr., Professor of Health Education
Kinkade, Richard Paisley, Professor of Spanish and Portuguese
Kinney, Janet Lynn, Assistant Professor of Pharmacy Practice
Kinney, Robert Bruce, Professor of Aerospace and Mechanical Engineering
Kircher, Henry Winfried, Professor of Nutrition and Food Science
Kirk, Samuel A., Professor of Special Education
Kirk, Walter K., Professor Emeritus of Finance, Insurance and Real Estate
Kirsch, Evelyn Jones, Lecturer Emerita in English
Kisler, Clayton Ward, Associate Professor of Anatomy
Kisagawa, Chisato, Associate Professor of Oriental Studies
Klais, Donald Stanley, Professor Emeritus of Sociology
Kloeppe, Dee Lee, Assistant Professor of Accounting
Klein, Gary Stephen, Assistant Professor of Management Information Systems
Klein, Raymond Louis, Professor of Secondary Education
Klemmedson, James Otto, Professor of Range Management
Kneebone, William Robert, Professor of Plant Sciences
Kneif, Lotus Mae, Professor Emeritus of Educational Psychology
Knight, George P., Assistant Professor of Psychology
Knorr, Amy Jean Holmblade, Professor of Home Economics
Knorr, Philip Noel, Professor of Forestry
Knudson, Ronald Joel, Professor of Internal Medicine
Kobernick, Marc Even, Assistant Professor of Surgery
Kodric-Brown, Astrid, Assistant Professor of Ecology and Evolutionary Biology
Koff, Theodore H., Associate Professor of Public Administration and of Family and Community Medicine
Koffler, Henry, Professor of Biochemistry and of Molecular and Medical Microbiology
Kohler, Sigurd, Professor of Physics
Kohn, Ingeborg Margaret, Associate Professor of French and Italian
Kolodovsky, Otakar, Professor of Pediatrics and Physiology
Kolopoulos, Christ Leonidas, Assistant Professor of Optical Sciences
Konsynski, Benn R., III, Assistant Professor of Management Information Systems
Koppmann, Charles Frederick, Associate Professor of Surgery
Koppel, Gene S., Associate Professor of English
Kore, Murray, Assistant Professor of Internal Medicine
Korn, Granino Arthur, Professor of Electrical Engineering
Kornman, Sheryl Roselyn, Assistant Professor of Journalism
Kozolchyk, Boris, Professor of Law
Kramer, Roger Michael, Associate Professor of Home Economics
Kratchovill, Thomas Rudy, Associate Professor of Educational Psychology
Krausman, Paul R., Associate Professor of Wildlife Ecology
Krebs, Richard Carl, Professor of Secondary Education
Krementz, Gerhard Otto Wilhelm, Professor Emeritus of Geosciences
Kreulen, David Lee, Assistant Professor of Pharmacology
Krieger, E. Philip, Professor of Atmospheric Sciences
Kriegh, James Douglas, Professor of Civil Engineering and Engineering Mechanics
Krutksch, Philip Henry, Professor of Anatomy
Kuehl, Robert Otto, Professor in the Statistical Support Unit
Kukolich, Stephen George, Professor of Chemistry
Kutalilake, Pinnaduwa H.S.W., Assistant Professor of Mining and Geological Engineering
Labadie, Enrique L., Assistant Professor of Neurology
La Ban, Frank K., Professor of Speech Communication
Lada, Charles Joseph, Assistant Professor of Astronomy
Laetsch, Theodore Willis, Associate Professor of Mathematics
Laguna, Jose Francisco, Associate Professor of Neurology
Laird, Hugh Edward, Jr., Associate Professor of Pharmacology and Toxicology
Lake, Randy Kent, Assistant Professor of Aerospace Studies
Lakeman, Sandra Davis, Assistant Professor of Architecture
LaMarche, Valmore Charles, Jr., Professor of Dendrochronology
Lamb, George Lawrence, Jr., Professor of Mathematics and Optical Sciences
Lamb, Gerri S., Assistant Professor of Nursing
Lamb, Ursula S., Professor of History
Lamb, Willie E., Jr., Professor of Physics and Optical Sciences
Lamke, Leanne Kay, Assistant Professor of Home Economics
Lang, William Aloysius, II, Associate Professor of Drama
Langen, Herbert J., Professor of Business and Career Education
Lansing, Robert Wendall, Professor of Psychology
Larson, Carol F., Associate Professor of Elementary Education
Larson, Dennis Luverne, Associate Professor of Soils, Water and Engineering
Larson, Harold P., Associate Research Professor in the Lunar and Planetary Laboratory and of Planetary Sciences
LaSalle, James F., Professor of Management Information Systems
Laursen, Emmett M., Professor of Civil Engineering and Engineering Mechanics
Leuer, Philip J., Associate Professor of Counseling and Guidance
Law, Averill Martin, Associate Professor of Management Information Systems
Law, John Harold, Professor of Biochemistry
Lawall, John Scott, Assistant Professor of Psychiatry
Layton, Jack Malcolm, Professor of Pathology
Leavitt, Ernest Eastman, Jr., Lecturer in Anthropology and Curator of Exhibits in the Arizona State Museum
Leavitt, John Adams, Professor of Physics
LeBouton, Albert Vincent, Associate Professor of Anatomy
Lebowitz, Michael David, Professor of Internal Medicine
Ledford, Bruce Randall, Associate Professor of Secondary Education
Lee, Chi-Won, Assistant Professor of Plant Sciences
Lee, Jack Kenneth, Professor of Music
Lee, Stanley M., Assistant Professor of Internal Medicine and Pediatrics
Leebron, Elizabeth Joanne, Assistant Professor of Radio-Television
Lehman, Gordon Stanley, Associate Professor of Watershed Management
Lehrer, Adrienne Joyce, Professor of Linguistics
Lehrer, Keith Edward, Professor of Philosophy
Lei, K. Y., Associate Professor of Nutrition and Food Science
Leigh, Howard W., Professor Emeritus of Secondary Education
Leighton, Uvija Good, Assistant Professor of Speech Communication
LeMasters, Karen Lynne, Assistant Professor of Marketing
Lemen, Richard John, Associate Professor of Pediatrics
Lenoir, James Jefferson, Professor Emeritus of Law
Lenoir, Timothy Wayne, Assistant Professor of History
Leonard, John Lander, Lecturer in Mathematics
Leonard, Robert Earl, Professor of Sociology
Leshin, George J., Professor Emeritus of Special Education
Leslie, Larry L., Professor of Higher Education
Letson, Robert Justin, Professor of Secondary Education
Leventon, Alan Ira, Professor of Psychiatry
Levi, Daniel Jay, Assistant Professor of Psychology
Levin, Gary Marc, Assistant Professor of Computer Science
Levine, Norman, Assistant Professor of Internal Medicine
Levenson, Daniel, Associate Professor of Family and Community Medicine
Levy, Eugene H., Associate Professor of Planetary Sciences
Levy, Jerold E., Professor of Anthropology
Lewis, Frank A., Associate Professor of Philosophy
Lewis, John S., Professor of Planetary Science
Lichtenberger, Dennis L., Associate Professor of Chemistry
Lichter, Seth, Assistant Professor of Aerospace and Mechanical Engineering
Lieberson, Stanley, Professor of Sociology
Liebert, James W., Assistant Professor of Astronomy
Lightner, Elmer, Associate Professor of Pediatrics
Hikes, Keith Elmer, Assistant Professor of Pharmacology and Toxicology
Lim, Louise Chin, Associate Professor Emeritus of Mathematics
Lindell, Thomas Jay, Associate Professor of Pharmacology
Lindsay, Everett Harold, Jr., Professor of Geosciences
Lindsey, Douglas Hamilton, Associate Professor of Surgery and of Family and Community Medicine
Lippincott, William Thomas, Professor of Chemistry
Little, John Wesley, Assistant Professor of Biochemistry
Littler, Charles Armstrong, Professor of Art
Livermore, Joseph M., Professor of Law
Livermore, Shaw, Professor Emeritus of Public Administration
Lockard, William Kirby, Professor of Architecture
Logan, James Phillips, Professor of Management
Lomen, David Orlando, Professor of Mathematics
Lomont, John Slayback, Professor of Mathematics
Long, Austin, Associate Professor of Geosciences
Longacre, William A., Professor of Anthropology
Longman, Alice Jean, Associate Professor of Nursing
Loomis, Mary Elizabeth, Assistant Professor of Management Information Systems
Loomis, Timothy Patrick, Associate Professor of Geosciences
Lopez, Richard Leon, Jr., Assistant Professor of Elementary Education
Lovelock, David, Professor of Mathematics
Low, Frank James, Research Professor in the Steward Observatory
Lowe, Charles Herbert, Jr., Professor of Ecology and Evolutionary Biology
Lowell, Alice B., Professor Emerita of Home Economics
Lucas, C. Bickford, Assistant Professor of Journalism
Lucas, David C., Associate Professor of Molecular and Medical Microbiology
Ludovici, Peter P., Professor of Microbiology
Luz, Babette, Associate Professor Emerita of German
Lynch, Lillian, Associate Professor Emerita of Nursing
Lynch, Peter J., Professor of Internal Medicine
Lynn, Edward Shird, Professor of Accounting
Lynn, Klonda, Professor Emerita of Speech
Lytle, Clifford Merle, Jr., Professor of Political Science
MacCorquodale, Patricia L., Assistant Professor of Sociology
MacGregor, Ian L., Associate Professor of Internal Medicine
MacMillan, Peter Bruce, Assistant Professor of Oriental Studies
Mackinnon, Mary Matilda Sonntag, Assistant Professor of Nursing
MacKinnon, William John, Professor Emeritus of Psychology
MacLeod, H. Angus, Professor of Optical Sciences
MacLeod, Murdo John, Professor of History
Maskell, John Douglas, Professor of Architecture
Madden, Daniel, Associate Professor of Mathematics
Maddock, Thomas III, Professor of Hydrology and Water Resources
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Sparks, George Fray, Professor Emeritus of Speech Communication
Spearmann, Johnnie J., Jr., Assistant Professor of Military Science
Speace, Roy G., Jr., Professor of Law
Speer, Donald Pierce, Associate Professor of Surgery
Spera, Gianni, Associate Professor of French and Italian
Spicer, Edward H., Professor Emeritus of Anthropology
Spitzer, John, Professor of Molecular and Medical Microbiology
Sprules, George B., Professor of Home Economics
Sprunger, Lewis William, Assistant Professor of Pediatrics
Staley, Dean Oden, Professor of Atmospheric Sciences
Stamm, William Paul, Professor of Architecture
Stanhil, Alice Borden, Professor Emerita of Nutrition and Food Science
Stanghellini, Michael E., Professor of Plant Pathology
Stanisic, Thomas H., Associate Professor of Surgery
Stasiak, Dan, Professor Emeritus of Geography and Regional Development
Stanley, Ernest Brooke, Professor Emeritus of Animal Science
Stansfield, Philip Devon, Associate Professor of Pathology
Stark, Royal W., Professor of Physics
Stavroudis, Orestes Nicholas, Professor of Optical Sciences
Stead, Charles Richard, Assistant Professor of Military Science
Steele, Susan Myrtle, Associate Professor of Linguistics
Steelman, Cornelius, Professor of Chemistry
Stageman, George Ian Allen, Professor of Optical Sciences
Stein, Bernhardt E., Lecturer in Family and Community Medicine
Stein, Hans Fred, Lecturer in Internal Medicine
Steinbrenner, Arthur Henry, Professor of Mathematics and Secondary Education
Steinbronn, Del Vern, Assistant Professor of Surgery
Steinbronn, Karen Kraemer, Assistant Professor of Pathology
Stern, Lawrence Zachary, Associate Professor of Neurology
Stevenson, Frederick William, Associate Professor of Mathematics
Stewart, Harry E., Professor of Electrical Engineering
Stewart, Luan Wagner, Assistant Professor of Home Economics
Stinchcombe, Arthur L., Professor of Sociology
Stinli, William A., Professor of Anthropology
Stith, Lee S., Professor of Plant Sciences
Stockman, Lynn Homer, Professor Emeritus of Marketing
Stockton, Charles Wayne, Associate Professor of Dendrochronology
Stokes, Marsden 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 of Animal Science
Stouffer, Richard Lee, Assistant Professor of Physiology
Streitmatter, Janice Lynn, Assistant Professor of Secondary Education
Strittmatter, Peter Albert, Professor of Astronomy
Stroehlein, Jack Lee, Professor of Soils, Water and Engineering
Strom, Robert G., Professor of Planetary Sciences
Strugar, Debra Ann, Lecturer in Speech Communication
Stuart, Douglas Gordon, Professor of Physiology
Stubblefield, Thomas Mason, Professor of Agricultural Economics
Stull, J. Warren, Professor of Nutrition and Food Science
Sullivan, Jean Elizabeth, Assistant Professor of Family and Community Medicine
Sullivan, Michael Patric, Associate Professor of Political Science
Summers, George W., Professor of Management
Summer, John Stewart, Professor Emeritus of Geosciences
Sundaresan, Mallur K., Associate Professor of Electrical Engineering
Surwit, Earl A., Assistant Professor of Obstetrics and Gynecology
Sutherland, R. Warren, Professor of Music
Svob, Robert Stanley, Professor of Physical Education
Swanson, Gerald John, Associate Professor of Economics
Swearingen, C. Jan, Assistant Professor of English
Swetlinski, Daniel Maurice, Assistant Professor of Oriental Studies
Swihart, Thomas Lee, Professor of Astronomy
Swindell, William, Professor of Optical Sciences and Radiology
Swingle, Roy Spencer, Associate Professor of Animal Science
Swisher, Linda, Associate Professor of Speech and Hearing Sciences
Szilagyi, Miklos, Nicholas, Professor of Electrical Engineering
Tannenbaum, Peter, Assistant Professor of Mathematics
Tanner, Clara Lee, Professor Emerita of Anthropology
Tanakh, David Anthony, Associate Professor of Management
Tanz, Christine, Assistant Professor of Psychology
Tao, Jing-Shen, Professor of Oriental Studies
Tash, Jerry Cone, Associate Professor of Fisheries Science and Biological Science
Tausig, 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
Taylor, Tom James, Lecturer in English
Telfmaert, Stephen Gage, Lecturer in Mathematics
Temkin, Lawrence P., Assistant Professor of Internal Medicine
Terhorst, Robert, Professor of Spanish and Portuguese
Terwische, David Kenneth, Assistant Professor of Radio-Television
Terzeff, Ivan, Assistant Professor of Special Education
Teitel, Marcel, Professor of French and Italian
THAMES, John Long, Professor of Watershed Management
Theurer, C. Brent, Professor of Animal Science
Thews, Robert L., Professor of Physics
Thomas, Jo Ann, Lecturer in Medical Technology
Thomas, Robert Knox, Professor of American Indian Studies
Thomas, Violet Schuler, Associate Professor Emerita of Business and Career Education
Thompson, Charlotte Barclay, Assistant Professor of English
Thompson, Ethel Marion, Professor Emerita of Home Economics
Thompson, Glenn M., Assistant Professor of Hydrology and Water Resources
Thompson, Hugh C., Professor of Pediatrics and of Family and Community Medicine
Thompson, Joan W., Lecturer in Accounting
Thompson, Raymond Harris, Fred A. Rieker Distinguished Professor of Anthropology
Thompson, Richard Allen, Associate Professor of Anthropology
Thompson, Richard Bruce, Associate Professor of Mathematics
Thompson, Rodger Irwin, Associate Professor of Astronomy
Thomsen, Michael Alan, Lecturer in Radio-Television
Thomson, Donald A., Professor of Ecology and Evolutionary Biology
Thomson, Quentin Robert, Professor Emeritus of Aerospace and Mechanical Engineering
Thornburg, Hershel Dean, Professor of Educational Psychology
Thornburg, Martin Lynn, Professor Emeritus of Aerospace and Mechanical Engineering
Thrift, Inez E., Professor Emerita of English
Thweatt, William Henry, Associate Professor of Psychology
Tift, William Grant, Professor of Astronomy
Tindall, Robert Emmett, Jr., Associate Professor of Management
Tinsley, Ann Marie, Assistant Professor of Nutrition and Food Science
Tischler, Marc Eliot, Assistant Professor of Biochemistry
Titley, Spencer Rowe, Professor of Geosciences
Tobias, Robert Paul, Associate Professor of Art
Toland, Florence Winifred, Assistant Professor Emerita of Office Administration and Business Education
Tollin, Gordon, Professor of Biochemistry
Tomka, Peter Alexander, Professor of Political Science
Tomasko, Martin G., Associate Research Professor, Lunar and Planetary Laboratory
Tomizuka, Carl T., Professor of Physics
Tong, Theodore Gin Professor of Pharmacy Practice
Tormey, Thomas James, Professor Emeritus of Law
Toubassi, Elias, Associate Professor of Mathematics
Trautman, Rodes, Associate Professor of Library Science
Traver, Gayle Ann, Associate Professor of Nursing and Assistant Professor of Internal Medicine
Treat, Jay E., Associate Professor of Physics
Trejo, Armando Duenas, Professor of Library Science
Trifan, Deonise, Professor of Mathematics
Triffet, Terry, Professor of Civil Engineering and Engineering Mechanics
Tripp, Alice Merle, Assistant Professor of Nursing
Tucker, Thomas Curtis, Professor of Soils, Water and Engineering
Turner, Arthur Francis, Professor Emeritus of Optical Sciences
Turner, Paul R., Professor of Anthropology
Tuttle, Donald Monroe, Professor of Entomology
Twomey, Sean Andrew, Professor of Atmospheric Sciences
Urech, John Charles, Jr., Associate Professor of English
Umashankar, Sushila, Assistant Professor of Marketing
Umbrett, John, Assistant Professor of Special Education
Underwood, Jane H., Professor of Anthropology
Upchurch, Robert Phillip, Professor of Agronomy
Valdes-Cruz, Lillian Maria, Assistant Professor of Pediatrics
Valentini, Robert C., Assistant Professor of Mathematics
Valmont, William Jennings, Associate Professor of Reading
Van Asdell, Willard, Associate Professor of General Biology
Van de Voorde, Ronald Andre, Associate Professor of Library Science
Van Metre, Edward James, Lecturer in Secondary Education
Van Metre, Patricia, Associate Professor of Speech Communication
Van Slyck, Willard Nicholas, Jr., Professor Emeritus of Law
Van Wyck, David Bicknell, Assistant Professor of Internal Medicine and of Surgery
Van Zyl, Dirk J. A., Assistant Professor of Civil Engineering
Vargas, Gustavo A., Assistant Professor of Management
Vaucher, Yvonne E., Assistant Professor of Pediatrics
Vaughan, Robert William, Professor of Anesthesiology
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
Venugopalan, G. Krishna, Associate Professor of Chemistry
Venable, David Lawrence, Assistant Professor of Ecology and Evolutionary Biology
Verran, Joyce Ann, Assistant Professor of Nursing
Vickrey, Don William, Associate Professor of Accounting
Vikrey, Don William, Associate Professor of Accounting
Vignery, John Robert, Professor of History
Villar, Hugo V., Professor of Surgery
Vincent, Thomas Lange, Professor of Aerospace and Mechanical Engineering
Vivian, Richard Gwinnett, Associate Director of the Arizona State Museum and Lecturer in Anthropology
Vleck, David Joseph Alan, Assistant Professor of Ecology and Evolutionary Biology
Vogel, Ronald Joseph, Associate Professor of Public Policy, Planning and Administration
Voigt, Robert Lee, Professor of Plant Sciences
Vogt, Thomas John, Associate Professor of Political Science
Volz, Robert George, Professor of Surgery
von Isar, Aldine S., Assistant Professor of Special Education
von Teuber, Eugene John, Coordinator of International Programs
Vullien, Joseph J., Associate Professor of Physics
Vuturo, Anthony, Professor of Family and Community Medicine
Wachter, Bruce G., Lecturer in Geosciences
Wacks, Morton E., Professor of Nuclear and Energy Engineering
Wade, James C., Associate Professor of Agricultural Economics
Wagle, Robert Fay, Professor of Watershed Management
Walikie, John C., Professor of Political Science
Wait, James R., Professor of Electrical Engineering
Wait, John Vary, Professor of Electrical Engineering
Walker, H. Todd, Professor of Art
Walker, James M., Assistant Professor of Economics
Waller, Melanie Ruth, Assistant Professor of Marketing
Waller, William Stites, Assistant Professor of Accounting
Wallraff, Charles F., Professor Emeritus of Philosophy
Wang, Chiang, Assistant Professor of Systems and Industrial Engineering
Wangensteen, Stephen L., Professor of Surgery
Wangness, Roald Klinkenberg, Professor of Physics
Warburton, Jeffrey Lynn, Assistant Professor of Drama
Ward, Oscar G., Associate Professor of Ecology and Evolutionary Biology
Ware, George Whitaker, Jr., Professor of Entomology
Warner, Susan Aileen, Assistant Professor of Psychology
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, Associate Professor of English
Weaver, Albert Bruce, Professor of Physics
Weaver, Thomas, Professor of Anthropology
Weber, Charles Walter, Professor of Nutrition and Food Science and of Animal Science
Weber, Jean Draper, Professor of Statistics and of Management
Wegner, Thomas Norman, Lecturer in Animal Science
Weinsteina, 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
Wendel, John Richard, Lecturer in German
Wenders, John Thomas, Professor of Economics
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, Stephen Harry, Associate Professor of Oriental Studies
Westbrook, Robert Arthur, Associate Professor of Marketing
Wetman, Bryan R., Associate Professor of Radiology and Radiation Safety
Wetzel, Mary C., Associate Professor of Psychology
Wexler, David B., Professor of Law
Weymann, Ray John, Professor of Astronomy
Wheeler, Lawrence, Professor of Psychology and Optical Sciences
White, David Craig, Associate Professor of Pathology
White, Donald Henry, Professor of Chemical Engineering
White, Howard Dwaine, Assistant Professor of Biochemistry
Whiting, Allen S., Professor of Political Science
Whiting, Frank M., Professor of Animal Science
Wieland, John H., Professor Emeritus of Marketing
Wiersma, Frank, Professor of Soils, Water and Engineering
Wilcox, Robert Lewis, Lecturer in Nursing
Wild, Peter Thomas, Professor of English
Wilhelm, Mari Sue, Assistant Professor of Home Economics
Wilkening, Laurel Lynn, Associate Professor of Planetary Sciences
Wilkin, 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
William, James E., Lecturer in Agricultural Education
TEACHING AND RESEARCH FACULTY

Williams, Jean Marie, Associate Professor of Physical Education
Williams, Norman, Professor of Public Administration and Law
Williams, Robert Eugene, Professor of Astronomy
Williams, Theodore L., Associate Professor of Electrical Engineering
Wilmore, Jack Harrison, Professor of Physical Education
Wilska, Alvar P., Professor of Physics
Wilson, Clifton E., Professor of Political Science
Wilson, George Spencer, Professor of Chemistry
Wilson, Herbert Blair, Professor of Educational Foundations and Administration
Wilson, John Michael, Professor of Physical Education
Wilson, Lorne Graham, Hydrologist in the Water Resources Research Center
Wilson, Paul Nicholas, Assistant Professor of Agricultural Economics
Wilson, William Jerrem, Associate Professor of Oriental Studies
Wimmer, Gayle Ellen, Assistant Professor of Art
Wing, William Hinshaw, Professor of Physics and Optical Sciences
Winslow, Dianne Joan, Assistant Professor of Drama
Witsching, Paul Hugh, Professor of Aerospace and Mechanical Engineering
Wise, Edward Nelson, Professor Emeritus of Chemistry
Witkowski, James M., Assistant Professor of Civil Engineering
Witte, Charles Lionel, Professor of Surgery
Witte, Marlys Hearst, Professor of Surgical Biology
Wolf, Gerrit, Professor of Management
Wolf, Ray Alan, Assistant Professor of Pharmacy Practice
Wolf, Wendy Carolyn, Assistant Professor of Sociology
Wolfe, William Louis, Jr., Professor of Optical Sciences and Radiology
Wolf, Mary K., Assistant Professor of Physical Education
Woloshin, David Jordan, Professor of German
Wood, Bruce, Associate Professor of Mathematics
Wood, Elwin Grant, Professor Emeritus of Marketing
Wood, Mary Adele, Professor Emeritus of Home Economics
Woods, Alexander Hamilton, Associate Professor of Internal Medicine
Woods, Winton deRuyter, Jr., Professor of Law
Woodworth, Diane A., Lecturer in Medical Technology
Wooff, Neville John, Professor of Astronomy
Wooffenden, James Manning, Associate Professor of Radiology
Wortman, 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, Assistant Professor of Mathematics
Wright, Stephen Henry, Assistant Professor of Physiology
Wuensch, Allen Lloyd, Assistant Professor of Entomology
Wyant, James C., Professor of Optical Sciences
Wyant, Mary Elizabeth, Assistant Professor of Home Economics
Wyckoff, Ralph W. G., Professor of Microbiology and Physics
Wylie, Mary Jean, Associate Professor of Home Economics
Wyomere, 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 of Microbiology
Yamamura, Henry Ichiro, Professor of Pharmacology and of Biochemistry and Associate Professor of Psychiatry
Yappel, A. Ralph, Professor Emeritus of Aerospace and Mechanical Engineering
Yates, Alayne, Associate Professor of Psychiatry and Pediatrics
Yoffee, Norman, Associate Professor of Anthropology
Yoshino, I. Roger, Professor of Sociology
Yost, 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
Younggren, Newell Amos, Professor of General Biology
Zagoria, Salvatore Vincent, Professor Emeritus of Psychology
Zapotoczy, Joseph A., Professor Emeritus of Pharmaceutical Sciences
Zeches, Barbara Jean, Lecturer in Nutrition and Food Science
Zegura, Stephen L., Associate Professor of Anthropology
Zellen, Benjamin Holmes, III, Associate Research Professor, Lunar and Planetary Laboratory
Zink, Donald Larry, Assistant Professor of Microbiology and of Nutrition and Food Science
Zube, Ervin H., Professor of Renewable Natural Resources
Zukowski, Charles Frederick, III, Professor of Surgery
Zumbro, Nicholas L., Professor of Music
Zurbrick, Philip Raymond, Associate Professor of Agricultural Education
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 students' 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 home economics. 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 branch experiment stations and farms at Marana, Tucson, Safford, Yuma, and the Central Arizona Research and Extension Center at Maricopa. 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.

**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 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. They 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 Board. This public botanic garden has facilities for teaching and research. Situated on the edge of the low desert near Superior, Arizona, the Arboretum is a two-hour drive from the campus. Thirty acres of native and introduced plants from arid and semi-arid regions, together with about 1,000 additional acres of undisturbed fauna and flora, are under Arboretum control. Additionally, large tracts of relatively undisturbed habitats in a variety of biomes lie in the surrounding Tonto National Forest. Laboratory facilities and housing are available. The Arboretum is open from 8:00 a.m. to 5:30 p.m. daily except for Christmas Day.
The **BUREAU OF APPLIED RESEARCH IN 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 Colleges of Mines and Earth Sciences 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 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 **COMPUTER CENTER** provides facilities and services for the instructional, research, and administrative computing needs of the University community. Computer access can be obtained, at no charge, by all registered students.

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 Center provides terminals at various locations on campus as well as dial-up ports for access to these systems from individual laboratories and offices.

The Computer Center provides a variety of services to assist users in taking full advantage of the available computing resources. Such services include consulting on the use of the University’s shared computer systems, user acquisition of computing facilities, and interface between user-owned equipment and the University’s systems; noncredit short courses, open to the public, on use of the University’s systems; computer facility planning and preparation; selection, acquisition, integration, installation, and training in the use of user-owned computer systems acquired through the Center; and the dissemination of information through publications, manuals, reference books and periodicals, program library documentation, and consulting services.

The **DIVISION OF CONTINUING EDUCATION**, as an academic division of the university, provides daytime and evening classes as well as various special-interest courses and community programs on and off the campus. Students desiring graduate credit for graduate-level courses offered through continuing education or university extension auspices must first be admitted to the Graduate College on regular or unclassified graduate status. Specific graduate-level continuing education (on-campus) and university extension (off-campus) 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, and planning; to facilitate research by faculty members; and to disseminate information. To achieve its objectives the Division conducts research, both sponsored and unsponsored, publishes the *Arizona Economy*, monographs, special studies, and a chart book. In addition, the Division answers requests for information by business, government, and the general public.
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 INSTITUTE OF ATMOSPHERIC PHYSICS is a research organization placing particular emphasis on the study of aerosols, clouds and precipitation, atmospheric electricity, modelling 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 INSTITUTE OF GOVERNMENT RESEARCH (IGR) is a part of the Department of Political Science. It facilitates, supports, and coordinates research on a variety of governmental and public-policy topics of concern to political scientists, government officials, and the public, emphasizing those of particular relevance to Arizona and the Southwest. Topics include natural resources (water and energy), the environment, American Indian policy, and selected problems of government and public policy in Latin American countries. The Institute publishes occasional monographs and reports dealing with these topics and maintains a specialized political science reference and research library.

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 Earth Sciences, the Laboratory conducts a unique program of teaching and research in all aspects of dendrochronology. Graduate-level instruction is offered through cooperating academic departments, and a limited number of graduate research assistantships are available to qualified students. Current research efforts are directed toward the quantification of tree-ring parameters, the establishment of new tree-ring chronologies throughout the world, the understanding of basic tree growth and environmental relationships, the reconstruction of paleohydrologic and paleoclimatic 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. Staff for the Laboratory are drawn from members of the department and from those holding research appointments in the Lunar and Planetary Laboratory, some jointly with Steward Observatory. The Laboratory is housed in the Gerard P. Kuiper Space Sciences Building.

Laboratory staff are engaged in research and graduate instruction in conjunction with the Planetary Sciences Department. 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. Research programs of the Laboratory and Department include experimental and theoretical geochemistry, lunar and planetary geology, spacecraft imaging of planetary surfaces, the physics of planetary interiors; cosmic rays, the solar wind, astrophysical plasmas, polarimetry, infrared Fourier spectroscopy, planetary atmospheres, infrared astronomy, and astrophysics. Research programs at the Lunar and Planetary Laboratory are closely associated with the NASA space program and include numerous lunar and planetary missions. Several faculty of the Department and the Laboratory have been principal or co-investigators on space experiments including Apollo, Mariner, Voyager, and Pioneer spacecraft.

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, a neutron activation analysis laboratory, and the Space Imagery Center. In addi-
tion, the Laboratory conducts high-altitude observational programs for solar, planetary, and stellar infrared spectroscopy using NASA jet aircraft.

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 routinely at an average power level of 100 kilowatts with a thermal 'neutron flux of approximately $4 \times 10^{12}$ neutrons per square centimeter per second. Operation in the pulse mode with peak power levels of 680 MW and pulse widths of about 17 milliseconds is also routinely available.

The equipment is freely available for research work to all departments of the University interested in irradiation facilities. Objects of large size may be encased and lowered to the top of the reactor-core for exposure to neutron and gamma radiation. Smaller samples may be placed directly in one of the forty exposure positions provided.

There is also a pneumatic sample irradiation facility for use in research on short-lived radioactive materials, and external neutron beams may be brought out of the reactor for neutron radiography and for basic research with low-energy neutrons. A variety of gamma ray spectroscopy equipment options are 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, 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. GOLDMING 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 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, 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 facilities 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. The two 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.

UNIVERSITY LIBRARIES — The University Library system contains over 3,000,000 items including books, periodicals, microforms, maps, government publications, manuscripts, and 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, history of science, science fiction, and 18th- and 19th-century British and American literature. Through the Library the University is a member of the Association of Research Libraries and the Center for Research Libraries. Supplementary materials for graduate students writing theses and dissertations and for faculty and staff doing advanced research are available on interlibrary loan.

The University Library system consists of the Main Library, Science-Engineering Library, Music Collection, the Center for Creative Photography, and the Library Science Collection. Two large but separate library facilities are the College of Law Library and the Health Sciences Center Library at the Arizona Health Sciences Center. In addition, several other departmental libraries such as the Arizona State Museum Library, the institute of Government Research Library, the Division of Economic and Business Research Library, the Steward Observatory Library, the Computer Center Library, the Herbarium, and the Lunar and Planetary Sciences Library have been established to serve special research needs.

MAIN LIBRARY — Central Reference Department and main card catalog; Interlibrary Loan; Media Collection; Map Collection; Current Periodicals, Newspapers and Microforms Reading Room; Special Collections Department; Government Documents Department; Acquisitions Department; Catalog Department; Serials Department and Library offices.

SCIENCE-ENGINEERING LIBRARY — All materials on science and technology and the Oriental Studies collection.
MUSIC COLLECTION (Music Building) — Scores, sheet music, recordings, facilities for listening. Books about music are in the Main Library.

LIBRARY SCIENCE COLLECTION (Graduate Library School) — Materials about libraries and all aspects of library science.

CENTER FOR CREATIVE PHOTOGRAPHY — Books, periodicals, photographs, photographers' manuscript archives, and rotating exhibits covering all aspects of photography as an art form.

HEALTH SCIENCES CENTER LIBRARY — This specialized library, which serves the Colleges of Medicine, Nursing, and Pharmacy, the School of Health-Related Professions, and the University Hospital, contains over 100,000 cataloged volumes, 1,700 media programs, and receives approximately 3,000 current serial titles. The collection includes books, journals and nonprint materials in the health sciences.

LAW LIBRARY — This library now contains over 128,000 volumes plus 46,000 volume equivalents of microforms, 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 periodicals; and a carefully selected collection of legal encyclopedias, digests, treatises, and textbooks. There is also an expanding foreign law collection emphasizing Latin American law.

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. 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. The community of Tucson generates considerable artistic activity which, together with the splendid Tucson Museum of Art and a number of high quality commercial galleries, lends support to the University's art program.

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 Library possesses the most distinguished research collection for art in the Southwest, consisting of more than 45,000 volumes, and these holdings are continually growing.

UNIVERSITY OF ARIZONA PRESS — The book publishing arm of the University specializes in "works of merit in the subject-matter fields strongly identified with the institutions of higher learning in Arizona, and other significant nonfiction books of a regional nature about Arizona, the Southwest, and Mexico." Most titles are at college or adult level. Action on publishing acceptance is controlled by the University Publications Committee.

Manned by a professional publishing staff, the Press shoulders the accepted four basic responsibilities of a competent publisher: manuscript appraisal and selection; comprehensive editing and organizing; appropriate design and quality production; and effective marketing. The Press distributes in 85 foreign countries as well as throughout the United States. Works are in the English language, but rights for translations may be negotiated by the Press with foreign publishers.

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 in 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 and three urbanized watersheds, all in or near Tucson. Lastly, the Center is responsible for the dissemination of 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 living 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 substantial support from the state, and maintains both a historical museum and a research library in the Phoenix area. The museum and library are located adjoining the University campus and contain 5,000 maps and other materials. The manuscript collections, which are rich, with letters, diaries, journals, business records and other documents, range from the earliest (five major collections) and many of which are still partially or completely unpublished. One of its most valuable research resources is its collection of over 2,000 bound volumes of Arizona newspapers beginning with the first issue of the first newspaper 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, history, archaeology, 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 the 900 Research to apply toward requirements for an advanced degree, for 910 Thesis, and for 920 Dissertation.

The SOUTH WESTERN RESEARCH STATION of the American Museum of Natural History, New York, is located within a few hours of the University campus in the Chiwater Mountains of Arizona. The Station proper is located at an elevation of 5,400 feet in a moderate 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>
<thead>
<tr>
<th>Service</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration fee</td>
<td>$ 755.00</td>
</tr>
<tr>
<td>($377.50 per semester)</td>
<td></td>
</tr>
<tr>
<td>Residence halls, minimum rate*</td>
<td>555.00</td>
</tr>
<tr>
<td>Meals in university cafeteria</td>
<td>1,525.00</td>
</tr>
<tr>
<td>Books and supplies</td>
<td>200.00</td>
</tr>
<tr>
<td>Total minimum annual expense</td>
<td>3,035.00</td>
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NONRESIDENTS OF ARIZONA:

<table>
<thead>
<tr>
<th>Service</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>Registration fee</td>
<td>$ 755.00</td>
</tr>
<tr>
<td>($377.50 per semester)</td>
<td></td>
</tr>
<tr>
<td>Nonresident tuition fee***</td>
<td>2,665.00</td>
</tr>
<tr>
<td>($1,332.50 per semester)</td>
<td></td>
</tr>
<tr>
<td>Residence halls, minimum rate*</td>
<td>555.00</td>
</tr>
<tr>
<td>Meals in university cafeteria</td>
<td>1,525.00</td>
</tr>
<tr>
<td>Books and supplies</td>
<td>200.00</td>
</tr>
<tr>
<td>Total minimum annual expense</td>
<td>5,700.00</td>
</tr>
</tbody>
</table>

MISCELLANEOUS EXPENSES

Music fee for private lessons, per semester*** (½ hr. per week - $40, 1 hr. per week - $60). See General Catalog for details.

<table>
<thead>
<tr>
<th>Service</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late registration fee (any time after the scheduled 2-day period)</td>
<td>10.00</td>
</tr>
<tr>
<td>Change-of-schedule fee</td>
<td>2.00</td>
</tr>
<tr>
<td>Foreign student language examination fee (any one examination)</td>
<td>10.00</td>
</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>
<tr>
<td>Processing fee (thesis or dissertation)</td>
<td>10.00</td>
</tr>
<tr>
<td>Dissertation microfilm fee</td>
<td>25.00</td>
</tr>
<tr>
<td>Caps and gowns are purchased for $13.52 or $16.64, depending upon degree. Hoods are purchased for $13.00 or $15.60, depending upon degree.</td>
<td></td>
</tr>
<tr>
<td>Transcript fee, after one free transcript (Instantaneous service is $3.00)</td>
<td>1.00</td>
</tr>
</tbody>
</table>


* 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 $42.00 per unit per semester.

** Residence hall rates range from $555.00 to $1,153.00 per student per year.

*** For seven through 11 units of course work, the nonresident tuition per semester is: $777.50 for 7 units; $888.50 for 8 units; $999.50 for 9 units; $1,110.50 for 10 units; $1,221.50 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 — Several residence halls are reserved for graduate students. These halls are 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 Student Housing.

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 Family Housing Office; 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 Park Student Center. The range includes specialty snack bars, cafeterias, and a complete table-service restaurant. Campus vending locations are also offered. À la Board is the university meal plan that is available to all students. For additional information, write: À la Board, S.U.P.O. 10,000, Tucson, AZ 85720. Approximate monthly food cost for the average student is $150.00.

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

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. 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 the 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 (holding bachelor's degrees) who are not admitted to graduate degree programs may be admitted to Unclassified Graduate Status for the purpose of undertaking work to suit their needs. Also, 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-F and departmental requirements and materials from the major department. It is frequently very difficult to evaluate properly a foreign student's preparation in terms of American requirements for advanced degree programs. Most 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 close of the first semester of residence.

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 submitted before the student's application can be considered. New foreign students whose native language is not English must also take a locally administered English test and must enroll for any further English courses which may be recommended.
Foreign students on nonimmigrant visas are required by the University of Arizona to have Student Accident and Sickness Insurance coverage. Information and costs of this coverage are sent to those foreign students who are accepted for admission. The cost of the insurance is included in the amount of the financial guarantee. Insurance coverage is required for each term of enrollment. Some students are exempted from the University of Arizona insurance plan only when their government or sponsoring agency has submitted accident and sickness insurance plans acceptable to the University of Arizona. In addition, 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 should inform the Graduate Student Admissions Office-F, in advance, what the terms of support will be.

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; April 1 for the summer sessions. If the University is to bill for tuition and fees, billing must be through an embassy or an agent in the United States.

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 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 must be on file at least one month prior to registration. Applicants should also contact directly 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 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 will be 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 plan to take 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 in 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 the 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 500, 600, 700, and 900 are intended for graduate students, while approved 400-level courses, indicated by a GC in the Graduate Catalog, are taken for graduate credit by graduate students, and may be taken for graduate credit 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.) Courses at the 500 level are graduate; with prior written permission of the Dean of the Graduate College, exceptionally well-qualified seniors may enroll in 500-level courses. Courses numbered 600, 700 and 900 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”, “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 courses in the 6000 series may be applied toward the requirements of all graduate degrees.

TRANSFER OF GRADUATE CREDIT — The University of Arizona accepts graduate credit by transfer from other accredited institutions. There may be offered toward a master’s degree a whole number of transferred units not to exceed twenty percent of the minimum number of units required for the degree in question. Such transfer of credit may be established to apply 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 offered by 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, 699, 791, 793, 794, 799, 909, 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 specified, prior, written approval to take on a P-F basis (only the department head or the departmental graduate advisor may give such approval, which must be on file in the Graduate College office before registration); (b) any undergraduate, non-deficiency 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 per-semester enrollment limit 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 specified 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 courses required for their degrees and who still must register should enroll for supplementary registration (course number 930, one to nine units). Supplementary registration may be used concurrently with other enrollments to bring the total number of units to the required minimum.

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 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 Graduate College. 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 Graduate College.
GRADUATE STUDY IN SUMMER SESSIONS

The University of Arizona summer sessions give particular attention to graduate study. 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 the increasing 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 — The fee required of all students registered for credit is $42.00 for each unit. There is no additional nonresident fee for out-of-state students. In addition to the fee for the number of units elected, a registration fee of $17.50 is required of all students ($3.50 per week for those registering for short courses only).

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 Scholarships and Financial Aids, 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 1,800 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 $2,250 — $3,380 for services not exceeding ten hours a week, or $4,500 — $6,760 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 awards are available to qualified graduate students. The awarding of these scholarships is not automatic, and the number available is limited each year. Interested students should request financial aid applications from the Office of Scholarships and Financial Aids. The priority deadline for applications is May 1 (for the fall semester).

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 Scholarships and Financial Aids in February of the year the funds are required. The priority deadline for applications is 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. The Guaranteed Student Loan Application should be submitted to the Office of Scholarships and Financial Aids four months before the funds are required.


Professional and Graduate Degrees

MAJOR FIELD FOR PROFESSIONAL DEGREE

Major work leading to a Doctor of Pharmacy degree is offered.

MAJOR FIELDS FOR MASTER'S DEGREES

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

- accounting
- addiction studies
- aerospace engineering
- agricultural economics
- agricultural education
- agricultural engineering
- agronomy & plant genetics
- anatomy*
- animal physiology
- animal science
- anthropology
- American Indian studies
- applied mathematics
- architecture
- art
- art education
- art history
- astronomy
- atmospheric sciences
- bilingual/bicultural education
- biochemistry
- botany
- business administration
- business education
- cellular & developmental biology
- chemical engineering
- chemistry
- civil engineering
- composition (music)
- computer science
- counseling & guidance
- creative writing
- dairy science
- dietetics
- distributive education
- drama
- ecology & evolutionary biology
- economics
- educational administration
- educational media
- educational psychology
- electrical engineering
- elementary education
- engineering mechanics
- English
- English as a second language
- entomology
- finance
- food science
- foundations of education
- French
- general biology
- genetics
- geography
- geological engineering
- geosciences
- German
- health education
- higher education
- history
- home economics
- home economics education
- horticulture
- hydrology
- industrial engineering
- journalism
- landscape architecture
- Latin American studies
- library science
- linguistics
- management
- management information systems
- marketing
- mathematics
- mechanical engineering
- metallurgy
- microbiology
- mineral economics
- mining engineering
- molecular biology
- music education
- musicology
- music theory
- nuclear engineering
- nursing
- nutritional sciences
- optical sciences
- Oriental studies
- performance (music)
- pharmacology
- pharmacy
- philosophy
- physical education
- physics
- physiology*
- planetary sciences
- plant pathology
- plant protection
- political science
- poultry science
- psychology
- public administration
- range management
- reading
- rehabilitation
- renewable natural resources studies
- Romance languages
- Russian
- school library science
- secondary education
- sociology
- soil & water science
- Spanish
- special education
- speech & hearing sciences
- speech communication
- statistics
- systems engineering
- toxicology
- urban planning
- water resources administration
- watershed management
- wildlife and fisheries science

* 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
- genetics
- geography
- geological engineering
- geosciences
- higher education
- history
- horticulture
- hydrology
- linguistics
- mathematics
- mechanical engineering
- metallurgy
- 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 management
- watershed management
- wildlife and fisheries science

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

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

Professional Degree

Doctor of Pharmacy (Pharm.D.)

Advanced Degrees

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 Community College Personnel” in the College of Education section, General Catalog.
Requirements for Professional Degree

DOCTOR OF PHARMACY

The College of Pharmacy offers the Doctor of Pharmacy degree, which is the highest professional degree in pharmacy. The goal of the program is to educate and train the student in competencies in management, therapeutic, social-behavioral, communicative and educative skills necessary to the effective practice of pharmacy. The person who completes this degree is an advanced practitioner who can find opportunities for employment as a pharmacy faculty member, a clinical practitioner in facilities such as hospitals, ambulatory care clinics, extended care institutions, drug and poison information centers, private group medical practices, progressive community pharmacies and the drug industry.

The total program consists of 209 credit hours of which 66 credit hours are prepharmacy and 143 credit hours are earned in the professional program. Candidates for admission to the Doctor of Pharmacy program will be selected from those in the baccalaureate program. Students interested in pursuing a Doctor of Pharmacy degree are to make application to the program at the end of the second professional year. Admission to the program is based upon the candidate’s academic record, motivation, communicative skills and potential for leadership in professional service and/or education. Letters of recommendation, academic records and structured interviews will be used to assess the qualifications of each applicant.

For further information, see the “College of Pharmacy” section in the 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 for those who wish to prepare for a career in public accounting practice, in private business enterprise, in government service, or in the teaching of accounting in colleges and universities. Except as indicated below, the general regulations and requirements for the Master of Science degree apply.

A concentration in one of the various fields in accounting may be selected from the departmental graduate course offerings.

A score at the 60th percentile or above on the Graduate Management Admissions Test and an academic average of approximately "B" or better are required for admission consideration. Applicants must also have completed the equivalent of an undergraduate major in accounting together with upper-division course work in economics, statistics, business law, business finance, marketing, organizational behavior, production, and business policy.

Of the thirty required units, no fewer than fifteen must be in the field of accounting, and at least sixteen must be in course work open only to graduate students. A thesis is not required but, with departmental approval, from four to six of the fifteen required units may be replaced with thesis credit.

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 baccalaureate 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, home economics, 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.

The M.B.A. program is scheduled to cover four academic semesters. However, it can be completed by attending three semesters and one intervening summer. Through some course waivers, well-qualified students with undergraduate business majors may complete the program in three academic semesters.

The Admissions Committee reviews all applications on an individual basis. For the fall 1982 entering class, the average Graduate Management Admissions Test score was at the 80th percentile, and the average grade-point average was approximately 3.2.

The M.B.A. curriculum is as follows:

Prerequisites: It is recommended that undergraduate courses in Finite Mathematics (Math. 119) and Elements of Calculus (Math. 123), or their equivalents, be completed prior to entering the program. If this deficiency exists, it can be remedied by taking M.I.S. 400 or P.P.P.A. 400 in the first semester of the program.

Required Courses and Electives: There are 39 units of comprehensive core courses and 18 units of electives required for the degree. Elective courses and seminars are available to enable students to develop a concentration in virtually any field of business or public administration. Students completing the program in four academic semesters enroll in course work in the following sequence:

First semester: Acct. 550 (3), Econ. 500a (3), M.I.S. 501 (3), Mgmt. 502 (3), Mgmt. 552 (3); total units, 15.

Second semester: Acct. 551 (3), Econ. 500b (3), M.I.S. 553 (3), Fin. 511 (3), Mktg. 500 (3); total units, 15.

Third semester: Mgmt. 500 (3); Mgmt. 573 (3), Mktg. 470 (3), Fin. 556 (3), or P.P.P.A. 651 (3); electives (9); total units, 15.

Fourth semester: Mgmt. 571 (3); Electives (9), total units, 12.

Some required courses may be waived for those candidates who have previously completed comparable course work with superior grades. A minimum of thirty units of prescribed course work must be taken in residence at the University of Arizona.
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, school library science, secondary education, and special education.

Other Approved Majors: chemistry, English, French, general biology, geography, German, health education, history, home economics, 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. 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 two 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 or photographs of their studio work 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 reproductions of the exhibition must be submitted to the Art Department graduate committee upon completion of the final examination. The department reserves the right to retain for its departmental collection a selected work, or works, from those submitted. The candidate may be required to prepare a one-man 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-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, 605, 606, 449, 451, 452, 455 or 456, 650, 655, 475, 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.

**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. As many as six units may be earned for preparation of the required thesis. A more detailed description of this program is available from the Graduate Admissions Committee.

**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 the 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><strong>30</strong></td>
</tr>
</tbody>
</table>
MAJOR IN COMPOSITION

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>Advanced Composition (Mus. 640)</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 Theory (Mus. 621a-621b or 623)</td>
<td>3</td>
</tr>
<tr>
<td>Conducting (Mus. 570)</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
<td>3</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

A recital of original compositions is required of the student before applying for candidacy for the major in composition.

MAJOR IN MUSICOLOGY

<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>Music Theory</td>
<td>3</td>
</tr>
<tr>
<td>Introduction to Graduate Study (Mus. 600)</td>
<td>3</td>
</tr>
<tr>
<td>Electives</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
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</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>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Music Education</td>
<td>16</td>
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<tr>
<td>Major instrument or voice</td>
<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>
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<tr>
<td>Electives</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</tbody>
</table>

MAJOR IN MUSIC THEORY

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Music Theory</td>
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</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

This is a graduate professional degree designed to provide education and experience which emphasize capability during the early stages of management responsibility in governmental units or, related agencies and for systematic progression to higher management levels. The program is broadly based and comprehensive. Concentrations are available in public management, criminal justice administration, health services administration, public works administration, and long-term care administration. Students may also propose different concentrations after consultation with faculty advisers who will assist them in the development of a coherent program for the approval of the faculty. It is expected that such proposals will draw upon courses available throughout the University.
For admission consideration, a score at the sixtieth percentile or better on the Aptitude Test of the Graduate Record Examination is required. Applicants must have completed a course in finite mathematics (introduction to set theory, matrices, and probability) prior to admission or may take M.I.S. 400 or P.P.P.A. 400 during the first semester of graduate work.

The program requires a total of 51 graduate units including 24 units of management foundation (governmental and cost accounting, management information systems, microeconomics and public sector economics, organization theory, statistical decision-making and communications), nine units of public administration core (public policy, fiscal and budgetary administration, and research and evaluation methods), and 18 units in the chosen area of concentration. Students with a background in the social sciences or administration may receive exemption, through proficiency examinations or through waivers for course work, of up to fifteen units.

The following course sequences are recommended for the typical student:

First semester: Econ. 500a (3), Mgmt.502 (3), M.I.S. 501 (3), Acct. 572 (3), and Mgmt. 552 (3); total units, 15.

Second semester: Acct. 551 (3), P.P.P.A. 600 (3), P.P.P.A. 605 (3), and Econ. 534 (3); total units, 12.

Third semester: Mgmt. 500 (3), P.P.P.A. 610a-610b (3), electives or concentration area courses (6); total units, 12.

Fourth semester: concentration area courses, 12; total units, 12.

The MPA student is required to have electives approved as a program by his or her faculty advisor.

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 two 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 chairman 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.
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 sixty 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**

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. Students who have completed the master's degree with a major in nursing at another institution must have done so with a concentration in medical-surgical nursing or child nursing to enter the pulmonary and oncology specialist programs. Students must have completed a master's degree with a concentration in community health in order to enter the primary care specialist program which includes preparation as a family nurse practitioner.

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 (oncology, primary care or pulmonary). A minimum of sixty 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.

Prior graduate credit completed in a master's program elsewhere may be accepted in transfer if it is relevant to the degree program at this institution and if the student has kept abreast of current developments in the field. If in the judgment of the faculty the applicant does not demonstrate the knowledge and concepts that such prior course work would suggest, relevant course work more than six years old may be reduced to half credit and course work more than ten years old may be rejected.

A research paper and a final comprehensive examination are required.
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 (Micr. 120), general mycology (Micr. 227R), introductory immunology (Micr. 419), and pathogenic microbiology (Micr. 420); (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 departmental 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 recommendation 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 education. The student may minor either inside or outside of the College of Education as approved by the advisers 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 experience in schools. Exceptions to this requirement are made occasionally for students specializing in some areas within counseling and guidance, rehabilitation, and school psychology.

ADVISORY COMMITTEE — After successfully passing the Qualifying Examination, the student 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 chairman 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 proposed 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.

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 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. 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 departmental 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 the 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 of 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.
Departments and Courses of Instruction

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 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.
100-199: Primarily introductory and beginning courses.
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 495, 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.
Research (Credit varies) Individual research by graduate students, not related to a thesis or dissertation the student will write for an advanced degree.
GRADE AVAILABLE: S/P, C, D, E, K, W.

Case Studies (Credit varies) Individual study of a particular case, or report thereof.
GRADE AVAILABLE: S/P, E, K, W.

Master's Report (Credit varies) Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
GRADE AVAILABLE: S/P, E, K, W.

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.
GRADE AVAILABLE: S/P, E, K, W.

Dissertation (1 to 9) Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
GRADE AVAILABLE: S/P, E, K, W.

Graduate Recitals (1 to 9) For graduate students in music performance.
GRADE AVAILABLE: S/P, E, K, W.

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, Dee L. Kleepe, Edward S. Lynn, Lyle H. McHaff, Louis A. Myers, Jr.
Associate Professors Dan S. Dhaliwal, Jack O. Foltz, Taylor W. Foster, III, Don W. Vickrey
Assistant Professors William K. Salatka, Michael D. Shields, Ira Solomon, William S. Waller
Lecturers Loren B. Christenfeld, Patricia H. King, Julian R. Sayre, Joan W. Thompson

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 Public Policy, Planning and Administration departmental headnotes elsewhere in this catalog.

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

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

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

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

Principles of Auditing (3) GC I II Qualifications, duties and responsibilities of the professional auditor; the standard short-form opinion; rules of professional conduct of the American Institute of Certified Public Accountants; internal control; audit programs. P, 300b, Mgmt. 375.

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

Fund Accounting (3) GC II Budgetary and financial accounting, control, and reporting for governments and other non-for-profit organizations. P, 210 or 272.

Financial Accounting Theory (3) GC I Topics in accounting theory and alternative accounting practices. P, 300b or 553b.
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.

521. **Current Legislation and Tax Policy** (3) I The most recent legislation passed and proposed by Congress; the structure of the legislative and judicial processes; trends in tax legislation and insight into the causes for such trends. P, 320.

522. **Tax Planning and Practice** (3) I Selected topics of a tax-planning and tax-practice nature; extensive individual reading and research. P, 422.

523. **Estate Planning and Taxation** (3) II 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. P, 422, Mgmt. 426 or CR.

526. **Corporate Taxation** (3) II Advanced topics in the taxation of corporations and of stockholders' transactions in corporate shares. P, 401, 422.

527. **Tax Aspects of Real Estate Transactions** (3) II 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. P, CR 320.

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

550. **Financial Accounting Analysis** (3) II Principles and procedures underlying basic financial accounting processes and their application in the preparation and analysis of financial statements. Advanced degree credit available for nonmajors only. Open only to students admitted to BPA graduate programs.

551. **Managerial Use of Accounting Data** (3) II Case studies and text readings focused on utilization of accounting data in determining the possible results of alternative executive decisions. Advanced degree credit available for nonmajors only. Open only to students admitted to BPA graduate programs. P, 550, Econ. 500a or CR, Mgmt. 552 or CR.

553a-553b. **Financial Accounting** (3-3) S 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. P, 210 or 551.

556. **Tax Factors in Business Decisions** (3) II 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. P, 210 or 551.

572. **Financial and Fund Accounting Analysis** (3) I Principles underlying the accounting processes, controls, and reporting of profit-seeking and not-for-profit organizations. Advanced degree credit available for nonmajors only.


596. **Seminar**
   a. Computers in Auditing (3) I II (Identical with M.I.S. 596a)

610. **Contemporary Managerial Accounting Thought** (3) II Special topics in accounting theory and research. Of special interest to doctoral students. P, 510.

685. **Contemporary Financial Accounting Thought** (3) II Special topics in accounting theory and research. Of special interest to doctoral students. P, 582.

696. **Seminar**
   a. Auditing (1 to 3) I II
   b. Managerial Accounting (1 to 3) I II
   c. Taxation (1 to 3) I II
   d. Theory (1 to 3) I II

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**AEROSPACE AND MECHANICAL ENGINEERING**


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

Assistant Professors Kee-Ying Fung, Juan C. Heinrich, Edward J. Kershen, Seth H. Lichter, Robert A. Peterson, John S. Phelps (Emeritus)
88 DEPARTMENTS AND COURSES OF INSTRUCTION

900. **Research** (Credit varies) Individual research by graduate students, not related to a thesis or dissertation the student will write for an advanced degree.
*GRADES AVAILABLE: S/P, C, D, E, K, W.*

908. **Case Studies** (Credit varies) Individual study of a particular case, or report thereof.
*GRADES AVAILABLE: S/P, E, K, W.*

909. **Master's Report** (Credit varies) Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
*GRADES AVAILABLE: S/P, E, K, W.*

910. **Thesis** (Credit varies) Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
*GRADES AVAILABLE: S/P, E, K, W.*

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.
*GRADES 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, Dee L. Kleespie, Edward S. Lynn, Lyle H. Moff, Louis A. Myers, Jr.
Associate Professors Dan S. Dhaliwal, Jack O. Foltz, Taylor W. Foster, III, Don W. Vickrey
Assistant Professors William K. Salakka, Michael D. Shields, Ira Solomon, William S. Walder
Lecturers Loren B. Christenfeld, Patricia H. King, Julian R. Sayre, Joan W. Thompson

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 Public Policy, Planning and Administration departmental headnotes elsewhere in this catalog.

401. **Advanced Accounting I** (3) GC I 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.

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.

422. **Advanced Federal Taxation** (3) GC I II 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 Qualifications, duties and responsibilities of the professional auditor; the standard short-form opinion; rules of professional conduct of the American Institute of Certified Public Accountants; internal control; audit programs. P. 300b, Mgmt. 375.

481. **Accounting Information Systems** (3) GC I II The analysis, design and implementation of information systems, with special emphasis on accounting applications. P. M.I.S. 121; Acct. 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 or 272.

481. **Financial Accounting Theory** (3) GC I Topics in accounting theory and alternative accounting practices. P. 300b or 553b.
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.

521. **Current Legislation and Tax Policy** (3) I The most recent legislation passed and proposed by Congress; the structure of the legislative and judicial processes; trends in tax legislation and insight into the causes for such trends. P, 320.

522. **Tax Planning and Practice** (3) I Selected topics of a tax-planning and tax-practice nature; extensive individual reading and research. P, 422.

523. **Estate Planning and Taxation** (3) II 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. P, 422, Mgmt. 426 or CR.

526. **Corporate Taxation** (3) II Advanced topics in the taxation of corporations and of stockholders’ transactions in corporate shares. P, 401, 422.

527. **Tax Aspects of Real Estate Transactions** (3) II 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. P, CR 320.

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

550. **Financial Accounting Analysis** (3) II Principles and procedures underlying basic financial accounting processes and their application in the preparation and analysis of financial statements. Advanced degree credit available for nonmajors only. Open only to students admitted to BPA graduate programs.

551. **Managerial Use of Accounting Data** (3) II Case studies and text readings focused on utilization of accounting data in determining the possible results of alternative executive decisions. Advanced degree credit available for nonmajors only. Open only to students admitted to BPA graduate programs. P, 550, Econ. 500a or CR, Mgmt. 552 or CR.

553a-553b. **Financial Accounting** (3-3) S 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. P, 210 or 551.

556. **Tax Factors in Business Decisions** (3) II 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. P, 210 or 551.

572. **Financial and Fund Accounting Analysis** (3) II Principles underlying the accounting processes, controls, and reporting of profit-seeking and not-for-profit organizations. Advanced degree credit available for nonmajors only.


596. **Seminar**
   a. Computers in Auditing (3) I II (Identical with M.I.S. 596a)

610. **Contemporary Managerial Accounting Thought** (3) II Special topics in accounting theory and research. Of special interest to doctoral students. P, 510.

685. **Contemporary Financial Accounting Thought** (3) II Special topics in accounting theory and research. Of special interest to doctoral students. P, 582.

696. **Seminar**
   a. Auditing (1 to 3) I II  
   b. Managerial Accounting (1 to 3) I II  
   c. Taxation (1 to 3) I II  
   d. Theory (1 to 3) I II

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**AEROSPACE AND MECHANICAL ENGINEERING**


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

Assistant Professors Kee-Ying Fung, Juan C. Heinrich, Edward J. Kerschen, Seth H. Lichter, Robert A. Peterson, John S. Phelps (*Emeritus*)
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 30 units of graduate work, 24 of which must be at the 500 level. 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 are expected to begin dissertation research following satisfactory completion of the Qualifying Examination and to carry on this work continuously under the supervision of a dissertation director. The Preliminary Examination may not be scheduled until substantial progress has been made on the dissertation. Normally, the foreign language requirement will be fulfilled in French, German, or Russian. All students are expected to attend the weekly graduate seminar, to make progress reports on their research at the department’s research conference, and to give at least one public presentation concerning the dissertation upon its completion. The first draft copies of the dissertation, approved by the dissertation advisor, must be submitted to the examination committee members at least six weeks prior to the date of the final oral examination. Students are generally required to select the minor subject from another department, usually mathematics, physics or another branch of engineering.


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

408. Reliability Engineering (3) GC I Times-to-failure, failure-rate, and reliability function determination for early, useful and wearout lives; equipment reliability prediction and configuration optimization; spare part provisioning. P, Math. 223.

412. Probabilistic Design (3) GC I II Design (static and dynamic) with loads, materials and geometry as random phenomena; probability, reliability, distributions of variables; statistical algebras, design synthesis, optimization. P, 409a, C.E. 217.

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.

416. Mechanical Engineering Design Implementation (3) GC II Construction, testing and evaluation of prototype design; design iteration to arrive at final system configuration. 2R, 3L. P, 415.

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.


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.

437. Engineering Program Design and Implementation (2 to 4) GC II Numerical methods, finite difference and finite element methods, automatic mesh generation and display, computer algorithms, data base design, recent methods of program design and implementation, program documentation, distribution and maintenance. 2R, 3 to 6L. P, 310, 432, S.I.E. 272.

442. Heat Transfer (3) GC 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 Met. 450R)

450L. Metal Processing Laboratory (1) GC I (Identical with Met. 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 Nu.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 II 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.

485. Current Problems in Energy and Power (1 to 4) GC II (Identical with Nu.E. 465)
466. Stability and Control of Aerospace Vehicles (3) GC I Static and dynamic stability of rigid and non-rigid vehicles; automatic control of aircraft, missiles and spacecraft. P, 361.

467. Solar Energy Engineering (3) GC I (Identical with Nu.E. 467)

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

477. Environmental Impact of Energy-Related Systems (3) GC II (Identical with C.E. 477)


505. Modern Control Theory (3) II 1984-85 Controllability and stability for linear and nonlinear systems, observer design, qualitative 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)

508. Advanced Reliability Engineering (3) II Extension of 408; prediction of reliabilities of complex systems; maintainability; reliability and availability of maintained systems; advanced spare parts provisioning; safety. P, 408.

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 412; probabilistic design projects from industry; analytical research of probabilistic design theory; study and evaluation of topics from research papers and reports. P, 412.

518. Reliability Testing (3) II Replacement and nonreplacement tests; mean time between failure and reliability confidence limits; sequential testing; sampling; accelerated, sudden death, and suspended items testing. P, 408.

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; vorticity dynamics; 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)

548. Nature of Turbulent Shear Flow (3) II 1984-85 Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances. P, 542 or 560.
553. Aerodynamics of Propulsion (3) I 1983-84 Interior ballistics of rocket motors; ramjets, turbojets, turbofans; detonation wave theory; combustion chamber instability analysis; nozzle design. P, 461.

556. Combustion Gasdynamics (3) II 1983-84 Aerothermochemistry; fluid mechanics, thermodynamics, chemistry of propulsion and air pollution; reaction kinetics, combustion stability, detonation; singular perturbations in deflagration. P, 532a, 461.

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 Nu.E. 567)

569. Energy Use: Analysis and Management (3) I (Identical with Nu.E. 569)

585. Advanced Biomechanics (3) II 1984-85 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

AGRICULTURAL BIOCHEMISTRY AND NUTRITION
(See Nutritional Sciences)

AGRICULTURAL ECONOMICS

Professors Jimmye S. Hillman, Head, Robert C. Angus, Robert S. Firch, Roger W. Fox, Maurice M. Kelso (Emeritus), William E. Martin, Thomas M. Stubblefield
Associate Professors Dennis C. Cory, James C. Wade
Assistant Professors David L. Barkley, Eric A. Monke, Paul N. Wilson

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.
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*

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*

439. **Economic Statistics** (3) GC II Application and interpretation of statistical measures to problems in economics. Advanced degree credit available for nonmajors only. P. Math. 117e. (Identical with Econ. 439) *Angus*

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

450. **Agricultural Business Capital Management** (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. 2R, 3L. Field trips. 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 III (Identical with Geog. 471)

476. **Natural Resource Economics** (3) GC II Economic principles useful in analyzing problems and policies of natural resource use, development and conservation. P. Econ. 201b. (Identical with Econ. 476, W.R.A. 476, and Ws.M. 476)

477. **Economic Issues in Land Use Planning** (3) GC I Evaluating the economic efficiency of alternative land use control programs, including zoning, eminent domain, development taxation, and transferable development rights. P. Econ. 201a-201b. *Barkley*

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) *Martin*

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) *Firch*

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) *Wade*

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


**AGRICULTURAL EDUCATION**

Professors Floyd G. McCormick, *Head*, Clinton O. Jacobs, Kenneth S. Olson
Associate Professor Phillip R. Zurbrick
Lecturer Glen M. Miller

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. A thesis (for which a maximum of six units may be earned) plus thirty units must be completed.

MASTER OF AGRICULTURAL EDUCATION — For information concerning this degree see Requirements for Master's Degrees/Master of Agricultural Education elsewhere in this catalog.

438. Philosophy and Principles of Extension Education (2) GC II Social and economic significance of extension education in agriculture and home economics. P, twelve units of ag. or h.ec. (Identical with H.E.E. 438)

439. Extension Education Methods (2) GC I Objectives, criteria and procedures for developing and evaluating effective working relationships; the communication process, methods and techniques for efficient use of individual and mass media. P, six units of a.ed. or ed. (Identical with H.E.E. 439)

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
f. Public Relations in Extension (1 to 20) [Rpt./2] GC I (Identical with H.E.E. 497f)
g. Senior Workshop in Extension (2) [Rpt./3 units] GC II P, 438, (Identical with H.E.E. 497s)

597. Workshop
a. * Extension Communications (1 to 2) [Rpt./2] (Identical with H.E.E. 597a)
b. * Extension Credibility and Accountability (1 to 2) [Rpt./2] (Identical with H.E.E. 597c)
c. * Extension Credibility and Accountability (1 to 3) [Rpt./2] (Identical with H.E.E. 597d)
d. * Extension Credibility and Accountability (1 to 3) [Rpt./2] (Identical with H.E.E. 597u)
e. Principles of Extension Training (1 to 3) I (Identical with H.E.E. 597t)
f. Volunteer Staff Development in Extension (3) I (Identical with H.E.E. 597v, which is home)
g. 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 study. P, nine units of a.ed. or ed. Zurbrick

621. Program Planning and Evaluation (2) II Developing programs and evaluating results 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.
home economics* ........................................................ 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.

* This program is currently under revision. Contact the Department of Nutrition and Food Science for information.
450. Alternative Futures in Energy and Environment (3) II 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

453. Remote Sensing in Agriculture (3) GC I 1984-85 Remote sensing imagery applications and techniques in inventory, monitoring and analysis of imagery in the areas of soils, entomology, watershed hydrology and other agricultural fields. 2R, 3L. Field trips. P, photointerpretation experience.

497. Workshop
a. Recent Advances in Agricultural Science (1) [Rpt./4] GCS

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. McDaniel/Caldwell/Folliot

539. Statistical Methods (2) II I 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.
539n. Nonparametric Methods (1) I P, 539.
539r. Regression Analysis (1) I II P, 539.
539s. Sample Surveys (1) I 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 1983-84 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, Vine Deloria, Jr. (Political Science), N. Scott Momaday (English), James Officer (Anthropology)
Associate Professors Lawrence C. Evers (English), LaVerne Jeanne (Linguistics)
Assistant Professors Thomas M. Holm (Political Science), Alice Paul (Elementary Education), Leslie Silko (English)
Lecturer Emory Sekaquaptewa (Anthropology)

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 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 policy 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.
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 vita, published articles or other materials relevant to admission.

MASTER OF ARTS — 30 units, plus a six-unit thesis, which 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 director. The student should work closely with three faculty advisors to develop a challenging individual program. In addition to the thesis, a final master’s examination is required.

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 (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)
456. Southwest Studies I (3) GC (Identical with Sw.C. 456)
457. Southwest Studies II (3) GC (Identical with Sw.C. 457)
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
m. Studies in the Oral Tradition (3) [Rpt./9 units] I II (Identical with Engl. 596m, which is home)

ANATOMY

Professors Bryant Benson, Head, Jay B. Angevine, Jr., Philip H. Krutzsch
Associate Professors David E. Blask, C. Ward Kischer, Albert V. LeBouton, Bruce E. Magun
Assistant Professor Mary J. C. Hendrix
Lecturers William D. Barber, Norman E. Koelling

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 advisor, select anatomy as a minor field. The minor program will consist of at least sixteen units in anatomy.

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

555. Cancer Biology (3) II (Identical with M.Mic. 555)


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) Phase II Essentials of mammalian neural development, structure and function. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; G.Bio. 101b; Cell. 410. (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, and consent of department.

615. Introduction to Anatomical Literature (1) I II 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.

698. Seminar

ANIMAL PHYSIOLOGY

Committee on Animal Physiology (Graduate)

Professors Robert B. Chiasson, Chairperson, Mac E. Hadley, Donald E. Ray, Raymond E. Reed, Frederick B. Roby, J. Glenn Songer, Gerald H. Stott (Emeritus) Jack Wilmore
Associate Professor Ronald W. Hillwig
Assistant Professors Ronald Allen, Victor Convertino, Roger M. Enoka, Lynn A. Joens, William Schurg
Lecturer Thomas N. Wegner

The interdepartmental 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 another discipline approved by the committee to meet the needs of the student.
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; An.S. 412, 413, 414, 415R, 415L, 430, 436, 601, 635; Cell. 410a-410b, 412, 612; Chem. 460, 462a-462b, 480a-480b, 565a-565b; Ecol. 431, 488R, 488L; G.Bio. 484eR-484bR, 489; N.F.S. 406a-406b, 615, 617, 620; Micr. 521, 630; Ph.Sc. 430a-430b; Ph.Ed. 520, 525, 530, 550; Psio. 601, 605; Stat. 461; V.Sc. 400a-400b, 405, 423R, 423L, 458, 459, 601.

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

ANIMAL SCIENCES


Associate Professor R. Spencer Swingle
Assistant Professors Ronald E. Allen, Sue DeNise, William A. Schurg
Lecturers Gary R. Amundson, Thomas N. Wegner

The department offers programs leading to the Master of Science degree with a major in animal science, dairy science, or poultry science. Concentrations in animal breeding, animal nutrition, meat science, or animal physiology are available under each of the three majors. 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 soils, water and engineering.

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

412. Environmental Physiology of Domestic Animals (3) GC II Physiological responses and adaptations of domestic animals to their internal and external environment; how the responses and adaptations relate to productivity and management. P, 430; V.Sc. 250, 400a or 400b.

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 G.Bio. 321 or P.L.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, Chemor. 101b, 102b; G.Bio. 101a and three units of animal anat.-psio.

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


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.
Race Track Business and Financial Management (3) GC II Operational strategies involving taxes and other financial aspects of the animal racing industry. P, 342.

Food Analysis (3) GC II 1984-85 (Identical with N.F.S. 463)

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.

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

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

Poultry Production (3) GC II Application of biological principles to modern poultry production. Field trips. P, 430.

Horse Production (3) GC II Production, feeding, management, reproduction, and business aspects of modern horse management. 2R, 3L. Field trips. P, 415R, 430.

Beef Cattle Production (2) GC I The production, feeding, and management of beef cattle prior to finishing. Field trip. P, 430.

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

Composition and Structure of Meat (2) GC II 1983-84 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)

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

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

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

Mineral Metabolism (2) I 1983-84 (Identical with N.F.S. 622)

Ruminant Nutrition (3) I Recent findings in ruminant nutrition; the physiochemical processes of digestion and absorption; importance and metabolism of rumen microflora; normal metabolic and abnormal metabolic disorders; modes of action of feed stimulants. P, 430, 436; Chem. 241a, 243a.

ANTHROPOLOGY


Associate Professors Ellen B. Basso, Constance Cronin, Mary Ellen Morbeck, Susan U. Philips, J. Jefferson Reid, Alice E. Schlegel, Richard A. Thompson, Carlos Velez-Ibanez, Norman Yoffee, Stephen Zegura

Assistant Professor E. Wesley Jernigan


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 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 advisors.

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

The Bureau of Applied Research in Anthropology, a division of the Department of Anthropology, is a regional and international center for basic and applied research relating to culture change, urban and rural living, technological innovation, demography, and cross cultural management. Extensive archaeological, ethnological, and osteological collections are available in the Arizona State Museum. Field training in archaeological techniques is offered on both the graduate and undergraduate levels at the University of Arizona Archaeological Field School, which is operated jointly by the department and the Arizona State Museum. The Laboratories of Tree-Ring Research, Isotope Geochemistry, Paleoenvironmental Studies, and 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 1984-85 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)

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

405. **Urbanization** (3) GC I Cross-cultural survey of the study of urban areas, including development of the field, research findings, and theory.

406. **Political Anthropology** (3) GC II 1984-85 Comparative political structure and process; segmentary systems, evolution of the state; ideologies and bureaucracies in cross-cultural perspective; Third World and modern politics.

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

408. **Applications of Anthropology** (3) GC II Methods and results in the use of cultural anthropology in the solution of practical problems of human adjustment to changing conditions in the United States and in underdeveloped areas of the world.

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 symbolization in the primitive world; shamanism and possession; religious movements; religion in the modern world. (Identical with Reli. 411)
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)

416. Contemporary Indian America (3) GC II 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 G.Bio. 418a-418b)

419. Mexican American Culture (3) GC I Historical background, cultural institutions, identity problems, social relations, and expectations of people of Mexican ancestry in the United States. (Identical with M.A.S. 419)

420. Contemporary American Culture (3) GC II Diverse perspectives on American values as expressed in organization of kinship, space, bureaucracies, media, ethnic groups, religious sects and movements.


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 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 1983-84 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 1984-85 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)


432. Peoples of the Pacific (3) GC I 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 G.Bio. 433)

434. Quantitative Research Design (3) GC I Basic techniques of quantitative description and inference; topics in the statistical analysis of anthropological data.

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.


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.


440a-440b. Laboratory in Zooarchaeology (3-3) GC 1984-85 Fragmentary animal remains in archaeological interpretation. 440a: Diagnostic morphological features; role in cultural interpretation. 440b: Analytical techniques; lab. analysis; report preparation. 1R, 6L.

441. Organization of Museums (3) GC I Survey of the history, structure, and function of museums.
442. Processing of Museum Materials (3) GCII Principles and techniques of museum registration procedures, treatment and storage of specimens, and the use of museum collections in research, the classroom, and the community. 2R, 3L. P. 441.

443. The Archaeology of Pre-Classical Greece (3) GC (Identical with Class. 443)

445. Presentation of Museum Collections (3) GC I Method and theory in museum exhibit design. P. 441.

446. Museum Conservation Methods (3) GCII Basic procedures in the preservation, repair and restoration of archaeological and historical collections.

450. Social Stratification (3) GCII (Identical with Soc. 450)

451. Archaeology of North America (3) GC I Intensive survey of the development 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) GCII 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) GCII Development of culture in the Andean countries of South America from hunters and gatherers of the terminal Pleistocene through Inca civilization.

455. Ethnoarchaeology (3) GC II History, method, and theory of ethnoarchaeology with case studies of the use of ethnography in archaeological interpretation and theory-building. P. 235.

456. Old World Prehistory (3) GCII 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 1983-84 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) GCII 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) GCII (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)

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.

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

473. Primate Anatomy (4) GC I 1983-84 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 (Identical with G.Bio. 474R)

474L. Ethnobotany Laboratory (1) GC II (Identical with G.Bio. 474L)

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)

478. Nonverbal Communication (3) GC II 1984-85 Survey of nonverbal communication among humans (posture, gesture, facial expression, gaze direction and eye contact), with attention to the biological and cultural factors that determine form and meaning of such communication.

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 1984-85 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)

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

497. Workshop
   a. Physical and Forensic Anthropology I (2) GC I Consult dept. before enrolling.
   b. Physical and Forensic Anthropology II (2) GC I Consult dept. before enrolling.


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

514. Late Quaternary Geology (3) I 1984-85 (Identical with Geos. 515)

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

561. Paleo-Indian Geochronology (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 gathering and analyzing language data from an informant. 580b: Experience in making cross-cultural analyses. 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) 1983-84 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)

596. Seminar
   a. Practical Problems in Cultural Resource Management (3) II 1983-84 P. 436.
   e. Pre-Columbian Art (3) [Rpt. 4] I (Identical with Art 596e, which is home)
   q. Near Eastern Archaeology (3) [Rpt.] I II (Identical with Or.S. 596q, which is home)
   r. Quaternary Geochronology (1 to 4) I II (Identical with Geos. 596r, which is home)

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) I (Identical with Ed.F.A. 604)

635a-635b. Foundations of Archaeology (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.

642. Advanced Field Course in Archaeology (8) S Eight-week course in advanced archaeological methods, theory, and field techniques, including practical experience in excavation, observation, recording, care of specimens, lab. analysis, and interpretation. 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) 1983-84 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 Theories of language and language usage in relation to the analysis of nonlinguistic cultural phenomena and the production of ethnographic descriptions. P, six units of ling.

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

APPLIED MATHEMATICS

Committee on Applied Mathematics

Professors Bruce R. Barrett (Physics), James M. Cushing (Mathematics), Donald G. Dudley (Electrical and Computer Engineering), William G. Faris (Mathematics), Paul C. Fife (Mathematics), Hermann Flaschka (Mathematics), Richard H. Gallagher (Civil Engineering), Wilfred M. Greenlee (Mathematics), Joseph F. Gross (Chemical Engineering), Robert L. Hamblin (Sociology), David L. Hetrick (Nuclear and Engineering), Frederic A. Hopf (Optical Sciences), William B. Hubbard (Planetary Sciences), Bobby R. Hunt (Systems and Industrial Engineering, Optical Sciences), J. Randolph Jokipii (Astronomy, Planetary Sciences), Granino A. Korn (Electrical and Computer Engineering), George L. Lamb, Jr. (Mathematics, Optical Sciences), Willis E. Lamb, Jr. (Optical Sciences, Physics), David O. Lomen (Mathematics), David Lovelock (Mathematics), Roy Marsten (Management Information Systems), David W. McLaughlin (Mathematics), Richard L. Morse (Nuclear and Energy Engineering), Alan C. Newell (Mathematics, Arizona Research Laboratories), Charles M. Newman (Mathematics), Michael L. Rosenzweig (Ecology and Evolutionary Biology), Hannes Rund (Mathematics), William M. Schaffer (Ecology and Evolutionary Biology), William R. Sears (Aerospace and Mechanical Engineering), Vernon L. Smith (Economics), Orestes N. Stavrovodes (Optical Sciences), Arthur L. Stinchcombe (Sociology), Terry Triffet (Engineering Mechanics), Thomas L. Vincent (Aerospace and Mechanical Engineering), James R. Wait (Electrical and Computer Engineering)

Associate Professors Gregory R. Baker (Mathematics), David P. Dobkin (Computer Science), Robert L. Gall (Atmospheric Sciences), Barry C. Ganapati (Nuclear & Engineering), Eugene H. Levy (Lunar & Planetary Laboratories), Olgiert Palusinski (Electrical and Computer Engineering)

Assistant Professor Kee-Ying Fung (Aerospace & Mechanical Engineering), Juan C. Heinrich (Aerospace & Mechanical Engineering), Chris K. Jones (Mathematics), Edward J. Kerschen (Aerospace & Mechanical Engineering), Randall Richardson (Geosciences), 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 Committee on Applied Mathematics encourages interdisciplinary research and advanced study in applied mathematics. Its programs allow graduate students with diverse backgrounds to sharpen their analytical skills and to apply them to their own disciplines. Simultaneously, it encourages mathematics majors and others with substantial analytical talents to apply their skills to exciting scientific and important applied problems. Development of the program is partially a response to an increasing need in industry and government for graduates skilled in the techniques of applied mathematics. Likewise, it recognizes a continuing need in the physical sciences and engineering, as well as a growing need in the biological and social sciences for scientists skilled in mathematical analysis and modeling.

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.

ARABIC

(See Oriental Studies)

ARCHITECTURE


Associate Professors Harry der Boghiasian, Robert W. Dvorak
Assistant Professors Dennis Doxtater, Sandra D. Lakeman, Robert L. Nevins
Lecturer Richard Ebeltlof

The College of Architecture offers a graduate 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 Psych. 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.


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. 437i)

596. Seminar

a. Readings in Architecture (2) [Rpt.] I II Open to majors only.

b. Interdisciplinary Environment-Behavior-Design (3) I (Identical with Idis. 596u, which is home)

597. Workshop

a. Architecture (3 to 8) [Rpt.] I II Open to majors only.

ARID LANDS RESOURCE SCIENCES

Committee on Arid Lands Resource Sciences (Graduate)

Professors Jack D. Johnson, Chairperson, Robert B. Bechtel (Psychology), Daniel D. Evans (Hydrology and Water Resources), C. John Maré (Veterinary Science), Paul S. Martin (Geosciences), Richard W. Reeves (Geography), Ervin H. Zube (Renewable Natural Resources)

Associate Professors Timothy J. Finan (Anthropology), James C. Wade (Agriculture Economics)

Assistant Professor Charles F. Hutchinson, Coordinator, (Geography)

108 DEPARTMENTS AND COURSES OF INSTRUCTION
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 coordinator 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 G. Boelts, Sam Scott, Gayle E. Wimmer

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. Advanced Figure Drawing (3) [Rpt.] GC I II 6S. P. six units of 305.
409. Special Problems in Drawing (3) [Rpt.] 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. 341, acceptance of portfolio by Portfolio Committee.
444. Nonsilver Photography (3) [Rpt./2] GC II Familiarization with alternative processes of photographic printing. 2R. 2S. P. 244, 341, acceptance of portfolio by Portfolio Committee.
446. Color Photography (3) [Rpt./2] GC I II Exploring conceptual and practical aspects of color picture-making with an emphasis on darkroom skills and the development of personal imagery. 2R. 2S. P. 441, acceptance of portfolio by Portfolio Committee.
447. Mixed Media Book (3) [(Rpt./1)] GC I I 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.] 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.] 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.
469. Experimental Illustration (3) [Rpt./2] GC II Experimentation, interpretation and problem-solving through illustration. 6S. Field trips. P. 368, 369, acceptance of portfolio by Portfolio Committee.
471. Advanced Jewelry and Metalsmithing (3) [Rpt./1] GC I II Advanced study of the various materials and methods in the construction of jewelry and metalwork. 6S. P. twelve units of metalwork.
473. Advanced Ceramics (3) [Rpt.] GC I II Individual studio research and instruction, with emphasis on personal creative development. 1R. 4S. P. 273.
476. Advanced Fibers (3) [Rpt.] GC I II Individual interpretations of concept into finished fiber works. three of the following: 278, 279, 376, 377.
480. Advanced Painting (3) [Rpt.] GC I II 6S. P. six units of 305, 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 I 1983-84 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 S Advanced design and fabrication of wood products, both utilitarian and sculptural. 6S. P, 286.

487. **Advanced Sculpture** (3) [Rpt.] GC I II 6S. P, 287.

506. **Special Problems in Figure Drawing** (3) [Rpt./4] I II 6S. P, 405.

510. **Graduate Problems in Drawing** (3) [Rpt.] I II Individual exploration in drawing media and visual concepts, with individual and class critiques. P, 409.

515. **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.

516. **Graduate Illustration** (3) [Rpt./1] I II Exploration of any optical material or phenomenon as a possible solution to illustration problems. 6S. P, 466, acceptance of portfolio by Portfolio Committee.

520. **Graduate Painting** (3) [Rpt./4] I II 6S. P, six units of 405, six units of 480.

521. **Intermedia Studio** (3) [Rpt.] I 1983-84 Individual and group projects incorporating elements of vision, sound, dance, drama, literature; access to camera, tape recorder is helpful. Field trips.


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

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.] I II Graduate study in all phases of jewelry and metalwork. 12 to 20S.

673. **Graduate Studio in Ceramics** (6 to 10) [Rpt./30 units] I II S 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.] 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.] 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.

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### Art History Courses

411. **Etruscan and 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, two of the surveys (117, 118, 119), 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 1983-84 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: I 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: I 1983-84 Development of painting in the Netherlands and France from the 14th through the 16th centuries. 414b: I 1984-85 Painting, sculpture, and architecture in Holland and Flanders. P, six units of hist. or art hist. 414a is not prerequisite to 414b.

415a-415b. **Spanish Art and Architecture** (3-3) GC 1984-85 415a: History of Spanish art and architecture from cave painting through the Gothic. P, six units of hist. or art hist. or Hispanic study. 415b: Painting, sculpture and architecture in Spain from the Renaissance to the present. P, two of the surveys (117, 118, 119), or six units of hist. or Span. literature. 415a is not prerequisite to 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.
DEPARTMENTS AND COURSES OF INSTRUCTION

418a-418b. 20th-Century Art (3-3) GC Painting and sculpture in Europe. 418a: 1886 to World War I. 418b: Between the World Wars. P, six units of hist. or art hist. 418a is not prerequisite to 418b.

421.  Painting in China and Japan (3) GC I 1983-84 Chinese painting from the Han to the Sung dynasty; Japanese painting from the Asuka to the Edo period. P, 117 and 118, or six units of hist. or Or.s.

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. 426b: 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 II 1984-85 Painting, sculpture, and architecture of the Baroque and subsequent periods. P, six units of hist. or art hist.

429a-429b-429c. American Art (3-3-3) GC Art in the United States. 429a: Colonial art. 429b: 19th century art. 429c: From 1900 through 1940. 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 times through the last stages of the Byzantine style. P, two of the surveys (117, 118, 119), or six units of hist.

515a-515b. Mexican Art and Architecture (3-3) 1984-85 Ibero-American art and architecture from the beginning of colonialism to the present. 515a: Gothic and Cathedral periods. 515b: Baroque, Neo-classical and modern periods. P, six units of hist., art hist. or L.A.S. (Identical with M.A.S. 515a-515b)

598. 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
   d. Pre-Columbian Art (3) [Rpt./4] I Consult instructor before enrolling. (Identical with Anth. 596e)
   e. History of Photography (3) [Rpt./4] I II P, 424a or 424b.

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.

Art Education Courses

430. Visual Arts in Elementary Education (3) GC I II Emphasis on perceptual development and art learning objectives in relation to cultural values; introduction to art elements, principles, and media through studio participation. 2R, 2S. P, Ed.P. 301 or 311.


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.

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.
ASTRONOMY

Professors Peter A. Strittmatter, Head, J. Roger Angel, Bart J. Bok (Emeritus), George V. Coyne, Walter S. Fitch, William F. Hoffmann, J. R. Jokipii, Frank J. Low, Aden B. Meinel, George H. Rieke, Elizabeth Roemer, Thomas L. Swihart, Rodger I. Thompson, William G. Tiff, Ray J. Weymann, Neville J. Woolf
Associate Professors William J. Cocke, Andrzej G. Pacholczyk, John S. Scott, Raymond E. White
Assistant Professors Charles J. Lada, James W. Liebert

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 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; infrared astrophysics; spectrographic and photometric research on single and multiple stars; astronomical instrumentation, theoretical investigations of stellar atmospheres and interiors, 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. 253, 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)

500. Observational Stellar Astronomy (3) II 1983-84 Basic observational spectroscopy and photometry, the stellar distance scale, stellar masses and diameters, variable stars, interstellar matter, star clusters and galactic structure, with emphasis on observational methods, data, and basic theories.

502. Introductory Astronomical Instrumentation and Technique (3) I 1984-85 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 1984-85 Ionization equilibrium; heating and cooling of HI and HII regions; determination of physical conditions from emission-line spectra; dark and reflection nebulae; interstellar grains.


535. Stellar Structure (3) II 1983-84 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 1984-85 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 1983-84 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) 1984-85 (Identical with Pty.S. 556a-556b)

575. General Relativity and Cosmology (3) II 1984-85 General relativity, with applications to cosmology and stellar structure; formation of stars and galaxies. Cocke/Weymann


ATMOSPHERIC SCIENCES

Professors William D. Sellers, Head, Louis J. Battan, George A. Dawson, Benjamin M. Herman, A. Richard Kassander, Jr. (Emeritus), E. Philip Krider, Richard M. Schotland, Dean O. Staley, Sean A. Twomey
Associate Professors Robert L. Gall, 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, and atmospheric chemistry.

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** — Atmo. 441a-441b or the equivalent from another university, plus 30 units, including Atmo. 451, Math. 461 or Agri. 539, and three 500 or 600-level atmospheric sciences courses, are required. All candidates must submit a thesis or a manuscript which has been approved for publication in an approved scientific journal.

**DOCTOR OF PHILOSOPHY** — The program requires completion of the requirements for the Master of Science degree and additional courses in the major and minor fields.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>421.</td>
<td>Physical Climatology (3)</td>
<td>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.</td>
</tr>
<tr>
<td>427.</td>
<td>Bioclimatology (3)</td>
<td>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)</td>
</tr>
<tr>
<td>441a-441b.</td>
<td>Dynamic Meteorology (3-3)</td>
<td>GC Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. P, Phys. 121; Math. 253 or 254.</td>
</tr>
<tr>
<td>451.</td>
<td>Physical Meteorology (3)</td>
<td>GC I Introduction to atmospheric physics, including atmospheric radiation, fluid mechanics, aerosol physics, cloud physics, and atmospheric electricity. P, Phys. 121; Math. 253 or 254.</td>
</tr>
<tr>
<td>471.</td>
<td>Synoptic Analysis (3)</td>
<td>GC I 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.</td>
</tr>
<tr>
<td>472.</td>
<td>Weather Forecasting (3)</td>
<td>GC II Techniques for weather forecasting and actual forecasting experience; advanced synoptic analysis. 1R, 6L. P, 471.</td>
</tr>
<tr>
<td>541.</td>
<td>Physics of the High Atmosphere (3)</td>
<td>II 1983-84 (Identical with Pty.S. 544)</td>
</tr>
<tr>
<td>561.</td>
<td>Radar Meteorology (3)</td>
<td>II 1984-85 Propagation, scattering, and attenuation of microwaves in the atmosphere and the use of radar for observing clouds, precipitation, thunderstorms, tornadoes and other meteorological phenomena.</td>
</tr>
<tr>
<td>575.</td>
<td>Atmospheric Aerosols (3)</td>
<td>I 1983-84 Physics, mechanics, and optics of individual atmospheric aerosol particles. Topics include formation dynamics, nucleation and growth, coagulation, scattering and absorption of radiation.</td>
</tr>
<tr>
<td>595.</td>
<td>Colloquium</td>
<td>a. Atmospheric Measurement Techniques (1 to 3) II 1984-85</td>
</tr>
<tr>
<td>641.</td>
<td>Theoretical Meteorology (3)</td>
<td>I Methods of solution of the hydrodynamic equations; identification and analysis of acoustic, gravity, Kelvin-Helmholtz, inertial, Kelvin, barotropic and baroclinic waves. P, 441b.</td>
</tr>
<tr>
<td>656a-656b.</td>
<td>Atmospheric Optics and Radiation (3-3)</td>
<td>1984-85 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 Optl. 656a-656b)</td>
</tr>
</tbody>
</table>
683. **Principles of Atmospheric Remote Sensing** (3) II 1984-85 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. 253.

(Identical with E.C.E. 683)

**BILINGUAL/BICULTURAL EDUCATION**

*(See Educational Foundations and Administration)*

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### BIOCHEMISTRY


Associate Professors Don P. Bourque, William J. Grimes, F. Raymond Salemme

Assistant Professors Nancy W. Downer, John W. Little, Marc E. Tischler, Howard D. White

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 with a major in biochemistry. 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 with a major in biochemistry.

Research areas in which graduate studies may be pursued include nucleic acid metabolism, biochemical virology, enzymology, lipid metabolism and chemistry, membrane structure and function, neurobiochemistry, complex polysaccharides, mammalian cell culture, mechanism of hormone action, biochemistry of vitamins and coenzymes, protein structure and function, bioenergetics, biological oxidations, photosynthesis, rapid reaction kinetics, visual processes, plant biochemistry, and biochemistry and genetics of cell organelles.

460. **General Biochemistry** (4 to 5) GC I Fundamentals of biochemistry, including proteins, nucleic acids, enzymes, carbohydrates and lipids and their metabolic relationships. 5 unit option includes additional lectures relevant to mammalian biochemistry. Open to nonmajors only. P, Chem. 241b. (Identical with Chem. 460)

462a-462b. **Biochemistry** (3-3) GC Introduction to the properties and metabolism of proteins, nucleic acids, enzymes, carbohydrates and lipids. Designed primarily for majors and minors in chem. and bloc. 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.

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)
BIOLOGICAL SCIENCES


569a-569b. Structure and Function of Biological Membranes (3-3) 1984-85 Physical and chemical properties of membranes and membrane components, photosynthesis, vision, cell surface phenomena and biosynthesis of membranes and membrane components. P, 462b. (Identical with Chem. 569a-569b)


617. Steroid Chemistry and Biochemistry (3) I 1984-85 (Identical with N.F.S. 617)

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

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
Cellular & Developmental Biology
Ecology & Evolutionary Biology
Entomology
General Biology

Genetics
Microbiology
Molecular and Medical Microbiology
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)
Home Economics (dietetics option)
Nursing
Nutrition and Food Science
Pharmaceutical Sciences

Pharmacology
Pharmacology & Toxicology
Pharmacy Practice
Speech & Hearing Sciences
Toxicology

BIOMEDICAL ENGINEERING
(See Engineering)

BOTANY
(See Ecology and Evolutionary Biology)
BUSINESS ADMINISTRATION

Committee on Business Administration

Professors Richard O. Mason (Management Information Systems), Chairperson, William B. Barrett (Associate Dean, Academic Affairs), Gerald D. Bierwag (Finance and Real Estate), James C. Cox (Economics)

Associate Professor Averill M. Law (Management Information Systems)
Assistant Professors Margaret A. Neale (Management), Melanie R. Wallendorf (Marketing), 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 Master's Degrees/Master of Business Administration elsewhere in this catalog.

DOCTOR OF PHILOSOPHY — The degree program is interdisciplinary, involving both the basic disciplines and the application of those disciplines. Applicants may come from either of two groups: (1) those with either undergraduate study or one year of graduate work in an area of business administration, or (2) those with undergraduate study either in a basic discipline applicable to business problems or in engineering. Individual programs may vary to take advantage of differing backgrounds or to accommodate different special interests.

During the first year of residence each student must pass a qualifying examination designed to check individual aptitude for continuance in the program and to facilitate the design of individual graduate programs by revealing areas of strength and weakness. All students must take a uniform core of courses in accounting, business finance, management, marketing, statistics, microeconomic and macroeconomic theory, management information systems, and must have or take a mathematical background which includes differential and integral calculus.

In addition to the core, the program requires a major in one of the concentration fields available in the college: accounting, finance, management, marketing, quantitative methods in business, management information systems, and regional development. The minor may be chosen from any department other than the major field but must have prior approval of the minor department.

BUSINESS AND CAREER EDUCATION

Professors Herbert J. Langen, Head, Richard A. Kidwell
Lecturer William H. Antrim

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.

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

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.

473. Professional Written Communication (3) GC II Principles and practice of the communication process in today's business and professional communities.

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 II S (Identical with Ed.F.A. 487)

497. Workshop

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

BUSINESS ECONOMICS

(See Economics)

CELLULAR AND DEVELOPMENTAL BIOLOGY

Professors Neil H. Mendelson, Head, H. Vasken Aposhian, Wayne R. Ferris, Konrad Keck, James W. O'Leary, Peter E. Pickens

Associate Professors Jennifer D. Hall, Martinez J. Hewlett, Kaoru Matsuda, Nobuyoshi Shimizu

Assistant Professors Wah Chiu, James F. Detherage

The Department of Cellular and Developmental 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 a major in cellular and developmental 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 May 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, 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; function, and integration of organelles and ultrastructural components of the cell. P, 103 (for majors), Chem. 243a or 480a. (410a is identical with G.Bio. 410a.)

412. Radioisotopes 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, G.Bio. 320 or 321. (Identical with G.Bio. 428R and Micr. 428R)

428L. Advanced Microbial Genetics Laboratory (2) GC II Individual research projects within the frame- work of microbial genetics, with emphasis on the genetic system of Bacillus subtilis. P, CR 428R. (Identical with G.Bio. 428L and Micr. 428L)


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. (Identical with Ecol. 463)

464aR-464bR. Human Physiology (3-3) GC (Identical with G.Bio. 464aR-464bR)

464aL-464bL. Human Physiology Laboratory (1-1) GC (Identical with G.Bio. 464aL-464bL)

514. Supramolecular Structure (2) II Application of diffraction techniques in the study of structure and function of biological macromolecules.

530. Current Topics in Eucaryotic Gene Expression (3) II 1984-85 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.

562. Plant Intermediary Metabolism (3) II 1984-85 Selected topics in plant metabolism and biosynthesis. 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 1983-84 Selected topics in growth and development. P. 460. (Identical with PL.S. 564)

568a-568b. Nucleic Acids (3-3) 1983-84 (Identical with Bioc. 568a-568b)

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.
Methods in Cell Biology (3) I Current techniques for qualitative and quantitative studies. 9L. Open to majors only.

CHEMICAL ENGINEERING

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

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, energy systems engineering, and materials engineering. For details concerning these options see Engineering elsewhere in this catalog.

Degrees

MASTER OF SCIENCE — Each student program must include 505, 506, and 530, and at least nine additional units of course work in chemical engineering or allied fields. A research project on an appropriate chemical engineering topic and proficiency in computer techniques are required. Ordinarily a thesis is required but, under extraordinary circumstances and with advance approval, a nonthesis program consisting of 33 units of approved course work plus two units of 696a is possible.

DOCTOR OF PHILOSOPHY — In addition to the requirements for the Master of Science degree, advanced work in mathematics, chemistry, physics, or other engineering fields is required. No foreign language is required.

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. Peterson

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.

430. Chemical Reaction Engineering (3) GC I Application of thermodynamic and kinetic fundamentals to the analysis and design of chemical reactors. P, 201, 306b. Shadman

435. Corrosion (2) GC II (Identical with Met. 435)

441. Chemical Engineering Design Economics (2) GC I Economic principles associated with equipment design, preliminary process design, and capital and operating cost estimation. P, CR 442.

442. Chemical Engineering Design Principles (2) GC I Basic design principles associated with pumps, compressors, heat exchangers, reactors, and distillation columns. P, 201, 203, 204, 304, 305; CR 430, 441.

443. Chemical Engineering Plant Design (2) 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, 441, 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.
DEPARTMENTS AND COURSES OF INSTRUCTION

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


514. Particulate Processes (3) II 1983-84 Dispersed-phase dynamics, population balances, particle growth kinetics, birth-death functions, phase space particle distributions, suspended-phase reactors, crystallization, and comminution. Randolph


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

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

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

585. Advanced Biomechanics (3) II 1984-85 (Identical with A.M.E. 585)


589. Energy Use: Analysis and Management (3) I (Identical with Nu.E. 569)


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

CHEMISTRY


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

Assistant Professors Peter F. Bernath, William M. Hetherington, Jeanne E. Pemberton

Lecturer Walter B. Miller, Ill
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 laboratory 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 measurements and instrumentation. 1R, 6L. 400a: P, 424 or CR; for majors, S.I.E. 170 or 272. 400b: P, 480a-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 1983-84 The systematic classification and identification of organic compounds. 1R, 6L. P, 241b, 243b or 245b, 325 or 322.

446. Organic Preparations (3) GC II 1984-85 Special experimental methods for the synthesis of organic compounds. 1R, 6L. P, 241b, 243b or 245b.

460.** General Biochemistry (4 to 5) GC I (Identical with Bioc. 460)

462a-462b.** Biochemistry (3-3) 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 sciences, including chemical dynamics, transport processes, thermodynamics, bonding, and spectroscopy. P, 480a.


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

510e-510b. **Advanced Inorganic Chemistry** (3-3) Survey at the advanced level of the chemistry of the elements. P, 410.

512. **Advanced Inorganic Preparations** (2 to 4) I 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 1983-84 Introduction to the determination of structures of complex molecules by X-ray crystallography; the evaluation of structural information; current topics in structural chemistry. 2R, 3L.


521. **Advanced Instrumental Analysis** (4) II Topics in spectrophotometry, emission spectrometry, chromatography, electroanalysis, principles of instrumentation and data acquisition at an advanced level. 3R, 3L. P, 424, 480b.

522. **Electroanalytical Methods** (3) II 1983-84 Principles of electrochemistry and electroanalysis, including topics on electrochemical equilibrium and kinetics, potentiometry, voltammetry, amperometry, coulometry, chronopotentiometry, and modern cyclic and pulse methods. P, 480b.

523. **Applications of Equilibrium Principles in Analysis** (3) II Mathematical description of equilibria in aqueous and nonaqueous systems; theoretical basis of analytical determinations. P, 480b.

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

525. **Chemistry of Metal Chelates** (3) I 1983-84 Theory underlying the application of organic reagents in chemical analysis. P, 523.


530. **Radiochemistry and Radiation Detection** (3) I (Identical with Nu.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) 1984-85 (Identical with Bioc. 565a-565b)

569a-569b. **Structure and Function of Biological Membranes** (3-3) 1983-84 (Identical with Bioc. 569a-569b)

572. **Metabolic and Hormonal Control of Cell Function** (3) I 1984-85 (Identical with Bioc. 572)

580. **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.

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

582. **Statistical Thermodynamics** (3) II Introduction to classical and quantum statistical thermodynamics with application to ideal gases and simple solids; equations of state and elementary solution theory. P, 480b.


613. **Kinetics and Mechanisms of Inorganic Reactions** (3) I An examination of the techniques and reasoning used in assigning reaction mechanisms. P, 510b.

614. **Organometallic Compounds** (3) I 1984-85 Compounds containing carbon-to-metal bonds, with emphasis on those of the transition elements, and the determination of their structures. P, 410.
615. Coordination Chemistry (3) I 1984-85 Selected topics in the area of coordination compounds of transition metals, with particular emphasis on ligand field theory, the symmetry aspects of the spectral properties of transition metal complexes and their magnetic behavior. P, 510b or CR.


617. Steroid Chemistry and Biochemistry (3) I 1984-85 (Identical with N.F.S. 617)

642a-642b. Polymer Chemistry (3-3) 1983-84 Synthesis, stereochemistry, and mechanisms of formation of high polymers. 642a: Condensation and ring-opening polymers. 642b: Vinyl polymers. P, 540. 642a is not prerequisite to 642b.

644. Heterocyclic Compounds (3) I 1983-84 The behavior of the more important heterocyclic systems. P, 540.


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

CHINESE
(See Oriental Studies)

CIVIL ENGINEERING AND ENGINEERING MECHANICS

Associate Professors Donald B. Hawes (Emeritus), Edward A. Nowatzki, Robert H. Wortman
Assistant Professors Gary L. Amy, Curtis W. Bryant, Mohammad K. Ehsani, Dirk J. A. van Zyl, 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, metallurgy, 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.


422. Irrigation Engineering (3) GC II (Identical with S.W.E. 422)

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, retaining walls, cofferdams and sheet piles, slopes; construction problems. P, 340.

452. Engineering Surveys (3) GC I CDT 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 I II Reading, interpretations, and geometric characteristics of aerial photographs; stereoscopic principles and their application in the production of planimetric and topographic maps. 2R, 3L. Field trips. P, 151, Math. 125a.

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.

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 382.

486a-486b. Occupational Safety and Health (3-3) GC (Identical with O.S.H. 486a-486b)

507. Drainage of Irrigated Lands (3) II (Identical with S.W.E. 507)

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)

544. Soil Stabilization (3) II Purpose of soil stabilization; stabilization using mechanical means, cement, asphalt, lime, salt and resins; 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.


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.


566. Highway Geometric Design (3) II 1984-85 Study of geometric elements of streets and highways, with emphasis on analysis and design for safety. P. 463.

567. Traffic Operations and Safety (3) II 1983-84 Application of traffic control devices for street and highways, design of traffic control systems, analysis and management of highway traffic, evaluation of safety. P. 463.

575. Microbiology of Sanitary Engineering (3) I Microbiological concepts and their application to natural and engineered systems for upgrading water and wastewater quality. 2R, 4L. P. 370.

577. Chemistry of Sanitary Engineering (3) I Chemistry of natural waters and water and wastewater treatment processes. Chemical thermodynamics, equilibria and kinetics are applied to environmental systems. Lab. emphasizes analytical methods. 2R, 3L. P. 370.

596. Seminar
a. Sanitary and Environmental Engineering (1 to 3) II

613. Theory of Elastic Stability (3) II Bending and buckling of prismatic bars, beams, rings, curved bars, thin shells, and thin plates under axial and lateral loads. P. 217, 302, or S.I.E. 270.

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.
Departments and Courses of Instruction


623. Flow through Hydraulic Structures (3) II 1984-85 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) I 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.

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.


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.


676. Advanced Water Distribution and Treatment System Design (3) II Administration, financing, design, construction, and operation of water treatment plants and distribution 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 (3) 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)

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.

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.

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.

CLASSICS

Professors Norman Austin, Head, Garnet D. Percy (Emeritus), David Soren
Associate Professors Richard C. Jensen, Thomas D. Worthen
Assistant Professor Charles T. Chamberlain
Lecturers Robert A. Burns, Donna E. Swaim

No advanced degree in classics is offered. In addition to a number of courses open, with the consent of the instructor, to all graduate students, the department offers one course, 599, restricted to those who are doing research involving the use of the Greek and Latin languages and who have been admitted to advanced degree programs in the university.

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)

411. Etruscan and Roman Art and Architecture (3) GC (Identical with Art 411)

417a-417b. Sanskrit Grammar and Texts (3-3) GC 1984-85 (Identical with Or.S. 417a-417b)

428. History of Byzantium (3) GC II (Identical with Hist. 428)

443. The Archaeology of Preclassical 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)

CLINICAL ENGINEERING
(See Engineering)

COMPOSITION
(See Music)

COMPUTER SCIENCE

Professors Ralph E. Griswold, Webb C. Miller
Associate Professors David R. Hanson, Head, Gregory R. Andrews, Peter J. Downey, Christopher W. Fraser
Assistant Professors Timothy A. Budd, Gary M. Levin, 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 1983-84 (Identical with Math. 402)
421. Simulation Modeling and Analysis (3) GC (Identical with M.I.S. 421)
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.
443. Theory of Graphs and Networks (3) GC II 1983-84 (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. 119 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 Linear Algebra (3) GC I (Identical with Math. 478)
479. Game Theory and Mathematical Programming (3) GC II 1983-84 (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.
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 II (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)*

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**COUNSELING AND GUIDANCE**

Professors O. C. Christensen, Roger J. Daldrup, Paul J. Danielson *(Emeritus)*, Bill W. Hillman

Associate Professors Philip J. Lauver, *Head*, Harley D. Christiansen, Richard L. Erickson, Gordon A. Harshman, Elizabeth B. Yost

Assistant Professor Betty J. Newton

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, classroom guidance, career counseling, student personnel work in higher education, and marriage, family, and agency counseling. A minor consisting of at least fifteen units is available for doctoral students majoring in other fields.

Forms and statements regarding application procedures for master's and doctoral programs are available on request from the department. Master's degree applicants must submit a personal data blank, a candidate's statement, letters of recommendation, and Miller Analogies Test score 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, and 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 must submit, to the Office of Graduate Study in Education, personal data blank, letters of recommendation, and scores on the aptitude test 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. Master’s application material for fall admission must be received by March 1 and by October 1 for spring admission. Doctoral application material for fall admission must be received by April 1 and November 15 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. 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.

401. Basic Skills in Counseling (3) GC I Selected counseling skills and their applications to noncounseling 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.

521. Techniques in Interviewing (3) 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 1984-85 (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) 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
  d. Anger, Depression and Guilt (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 Orientation to student personnel work in colleges and universities; interdisciplinary foundations; professional aspects; integrated lab. experience in selected campus settings. (Identical with H.Ed. 602)

607. The College Student (3) I Characteristics of the college student; interactions with campus environmental influences; developmental and normative trends. (Identical with H.Ed. 607)

617. Student Personnel Services in Higher Education (3) II Student personnel services; purposes; procedures; representative programs; current trends. (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.
643. **Counseling in the Schools** (3) I II Developmental approach to counseling, guidance, and consultation in the elementary and secondary school; observation and practice. P, 403, 601, 622.

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) I 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.

649. **Procedures in Marriage Counseling** (3) I II Application of counseling theory and techniques to the diagnosis of marital relationship and strategies for behavior change. P, 403, 601, 622.

661. **Management of Pupil/Student Personnel Programs** (3) I I I Services in public schools and/or post-secondary institutions. Area of individual student concentration will depend upon anticipated level of application. P, 12 units of coun.

682. **Group Techniques** (3) I I I 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 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 I
   b. Student Personnel Services (1 to 9) [Rpt.] I I
   c. Career Guidance (1 to 9) [Rpt.] I I

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 I
   b. Secondary School Counseling (1 to 9) [Rpt.] I I
   c. Higher Education Counseling (1 to 9) [Rpt.] I I
   d. Agency Counseling (1 to 9) [Rpt.] I I
   e. Family Counseling (1 to 9) [Rpt.] I I
   f. Group Counseling (1 to 9) [Rpt.] I I
   g. Marriage Counseling (1 to 9) [Rpt.] I I
   h. Career Counseling (1 to 9) [Rpt.] I I

795. **Colloquium**
   b. Professional Practice (1 to 3) [Rpt.] I I
   c. Counselor Education and Supervision (1 to 3) [Rpt.] I I
   d. Counseling Theory (Theory varies) (1 to 3) [Rpt.] I I
   f. Career Development (1 to 3) I I

**CREATIVE WRITING**
*(See English)*

**DAIRY SCIENCE**
*(See Animal Sciences)*

**DIETETICS**
*(See Home Economics and Nutrition and Food Science)*
DISTRIBUTIVE EDUCATION
(See Business and Career Education)

DRAMA

Professors Robert C. Burroughs, Head, Irene F. Comer (Emeritus), Robert A. Keyworth (Emeritus), Peter R. Marroney (Emeritus)
Associate Professors Harold W. Dixon, J. Michael Gillette, Rosemary Gipson, Peggy Kellner, William A. Lang, Jeffrey L. Warburton
Assistant Professors Jerry D. Allen, 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. The Master of Arts is an academic degree with a critical and scholarly emphasis. The Master of Fine Arts degree is a pre-professional training program emphasizing artistic achievement. 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.

410. Creative Drama (3) GC I Principles and procedures of improvisation, role-playing, creative playwriting techniques, and program development in creative dramatics applicable to the elementary and secondary school levels. P, twelve units of dram. or ed.

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 ed.


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. Scene 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.

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. P, 140a-140b.

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.
DRAMA 135


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-480b. 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.

496. Proseminar
   a. Portfolio (1 to 2) GC I II
   b. Cinema (1 to 2) GC I II

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 I II S
   d. Production Design (1 to 6) [Rpt./20 units] GC I II S
   e. Scenic Design (1 to 6) [Rpt./20 units] GC I II S
   f. Performance (1 to 6) [Rpt./20 units] GC I II S
   g. Cinema Production (1 to 6) [Rpt./20 units] GC I II S

560a-580b. 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.

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) 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 Moliere, the English Restoration, and similar historical texts. 2R, 2S. P, 655.
696. Seminar
a. Contemporary Trends (1 to 3) II
b. Special Topics in Acting (1 to 3) II
c. Special Topics in Directing (1 to 3) II
d. Musical Theatre Production (1 to 3) II
e. Directing the Full-Length Motion Picture (1 to 3) II
f. Film Editing (1 to 3) II
g. Documentary and Educational Films (1 to 3) II
h. Theatrical Design (1 to 3) [Rpt./3 units] I
i. Period Design Style (1 to 3) II

ECOLOGY AND EVOLUTIONARY BIOLOGY

Associate Professors Richard E. Michod, Stephen M. Russell, Oscar G. Ward
Assistant Professors Astrid Kodric-Brown, David I. Jablonski, 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 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.

411. Philosophy of the Biological Sciences (3) GC I 1983-84 (Identical with Phil. 411)
412. Plants Useful to Man (2) GC S (Identical with G.Bio. 412)
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.
415. Environmental Physiology (3) GC II 1984-85 Analysis and synthesis of recent studies of the physiological responses of animals to their environments. P. 468R.
434. Population Interactions (3) GC I Empirical and theoretical treatment of competition, exploitation, and mutualism within and between species and in communities. P. 102; Math. 223.
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 I (Identical with G.Bio. 436)
437. Flora of North America (2) GC II (Identical with G.Bio. 437)

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.


456. Developmental Biology (4) GC I (Identical with Cell. 456)

458. Comparative Vertebrate Anatomy (4) GC II (Identical with V.Sc. 458)

460. Plant Physiology (4) GC I II (Identical with Cell. 460)

462. Neurobiology Laboratory (1) GC II (Identical with Cell. 462)

463. Introduction to Neurobiology (3) GC I (Identical with Cell. 463)

467R. Endocrinology (3) GC II (Identical with G.Bio. 467R)

467L. Endocrinology Laboratory (1) GC II (Identical with G.Bio. 467L)

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, G.Bio. 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 p.l.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 1984-85 Identification and classification of the three largest flowering plant families of the Southwest. 6L.

475. Freshwater Algae (3) GC II 1983-84 Systematics, ecology, and evolution of planktonic and benthic species; field techniques and lab. culture. 2R, 3L. Field trips. P, four units of bio. or p.l.s.

476. Marine Algae (4) GC II 1984-85 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 p.l.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 p.l.s.

480. Invertebrate Zoology (4) GC I (Identical with G.Bio. 480)

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.

489. Parasitology (4) GC S (Identical with G.Bio. 489)
495. Colloquium
a. Problems in Plant Ecology (2) [Rpt./2] GC I (Identical with G.Bio. 495a)


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.


535. Tropical Ecology (2) II Attributes of tropical ecosystems, particularly tropical rain forests; special applications of ecological theory to tropical biotas; survey of recent literature. P, 102.

537. Advanced Ecology (2) [Rpt.] II Special topics in field ecology, with emphasis on study of natural habitats in the southwestern United States and northwestern Mexico. Field trips. P, 102. (Identical with W.F.Sc. 537 and Geos. 537)


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. (Identical with G.Bio. 542)

547. Ecology of Wildlife Reproduction (2) II (Identical with W.F.Sc. 547)

574. Recent Advances in Botany (2 to 3) [Rpt.] I II Recent advances in fields of botany selected on the basis of need and demand.

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.

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)

ECONOMICS


Associate Professors David E. Pingry (Acting Head), Richard D. Auster, Michael K. Block (Public Policy, Planning and Administration), Jon B. Christianson (Public Policy, Planning and Administration), John Z. Drabicki, Donald G. Heckerman, James C. McBrearty, Ronald L. Oaxaca, Gerald J. Swanson, Ronald J. Vogel (Public Policy, Planning and Administration)

Assistant Professors Soo Hong Chew, R. Mark Isaac, Kevin A. McCabe, Sharon Bernstein Megdal, Michael R. Ranson, Stanley S. Reynolds, Fernando M.C.B. Saldanha, Carol A. Taylor, James M. Walker

Lecturer R. Bruce Billings
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 Policy, Planning and Administration and Business Administration headnotes elsewhere in this catalog.

Applicants must submit scores on the aptitude and advanced economics tests 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.

**DOCTOR OF PHILOSOPHY** — 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.

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 Mgmt. 375.

435. **Public Sector Economics** (3) GC I 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.

439. **Economic Statistics** (3) GC I II (Identical with A.Ec. 439)

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 Bl.S. 463)

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.

500a-500b. **Micro-Macroeconomics** (3-3) 500a: Theory of price and its application. P. Math. 117c. 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)

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)

515. **Operations Research in Applied Economics** (3) I (Identical with A.Ec. 515)

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, Mgmt. 552. Advanced, degree credit available for nonmajors only.

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.
d. Comparative Economic Systems (1 to 3) I II P. 361.
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) 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.
o. Economic Growth and Development II (1 to 3) I II P. 501a, 502a.
p. Industrial Organizations I (1 to 3) I P. 501a; or 361 and Math. 123.
q. Industrial Organizations II (1 to 3) II P. 501a; or 361 and Math. 123.
r. Regional and Urban Economics I (1 to 3) I P, 501a; or 361 and Math. 123.
EDUCATION

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
- school library science ....................................... M.Ed./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, home economics, 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.

EDUCATIONAL FOUNDATIONS AND ADMINISTRATION

Professors Robert T. Grant, Head, Henry E. Butler, Jr. (Emeritus), John H. Chilcott, Lawrence O. Nelson, T. Frank Saunders, Marsden B. Stokes (Emeritus), Herbert B. Wilson
Associate Professors Lee A. Droegemueller, Stanley Pogrow, Donal M. Sacken, Macario Saldate IV (Director, Mexican American Studies and Research Center)
Assistant Professors Armanda 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 who have a limited knowledge of English. Interested students should consult the Director, Bilingual Programs. All students are required to complete 427, 540, 603, 625; Engl. 408; Rdg. 508; Elem. 526; 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, principal 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.

401. Environmental Education (3) GC I II (Identical with Geos. 401)

403. Study of Exceptional Children (3) GC I II (Identical with Spec. 403)

406. 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 P.P.P.A. 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.


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) 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) 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) 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)

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) II 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)

649. Theory and Behavior in School Administration (3) 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)

650. Personnel Administration in Education (3) I Composition of school staffs and the functions of various personnel; patterns and practices in school personnel management; issues, trends, and prospects in personnel management. P, fifteen grad. units in ed. or CR.

651. 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)

652. 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.

653. Planning and Maintenance of School Facilities (3) II Problems in the planning, construction, and maintenance of school facilities; visitation and evaluation of school facilities.

654. 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)

655. Supervision of the Instructional Program (3) II Purposes of instructional supervision: organization, techniques and skills for supervisory competency.

656. Higher Education and the Law (3) II (Identical with H.Ed. 677)

657. Educational Sociology (3) 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.

658. 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.

659. Curriculum Development and Supervision in Reading (3) II (Identical with Rdng. 683)

660. 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)

661. Colloquium
   a. Theory into Practice (1 to 4) I II
   b. The Administrator and the Organization (1 to 4) I II
   c. The Politics of Decision Making (1 to 4) I II
   f. Computer Applications in Educational Administration (1 to 4) I II
   m. Philosophy of Education (1 to 4) I II
   n. Social Foundations of Education (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)

662. 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)

663. 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)

664. Seminar
   a. Educational Administration (1) [Rpt./2] I II Open to majors only.
   b. Bilingual Education (3) I
EDUCATIONAL PSYCHOLOGY

Associate Professors Sarah M. Dinham, Joseph D. Gullo, Shitala P. Mishra, Rosemary A. Rosser
Assistant Professor Edward S. Shapiro

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 and DOCTOR OF PHILOSOPHY — Concentrations are available in early adolescence, learning and development, measurement and research, and school psychology. An internship is required in the school psychology concentration. Professional competency is required of all doctoral candidates in two of the following: (a) six-unit sequence in computer programming, (b) twelve-unit sequence in statistics and research methods, (c) nine-unit sequence in a relevant cognate area, and (d) an approved language.

For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

414. Mental Health in Education (3) GC I II The principles of mental health, with emphasis on effective personal adjustment in educational settings.

458. Psychological Measurement in Education (3) GC I II Psychometric methods as applied to the assessment of achievement, mental ability, and attitudes.
497. Microcomputers in Education (3) GC I II S (Identical with Ed.F.A. 487)

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. P, 302.

510. Psychology of the Educational Process (3) I II Major theories of learning, motivation, cognitive development and instructional design; emphasis on relationships between theory and practice. P, 310.

512. Individual Differences (3) II Psychological, social, and biological factors producing human variation and their implications for education. P, 310 or 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.

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.

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.

593. Internship
a. Research and Evaluation (1 to 6) [Rpt./2] I II Open to majors only.
b. College Teaching (1 to 6) [Rpt./2] I II Open to majors only.
c. Learning and Development (1 to 6) [Rpt./2] I II Open to majors only.

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, 501 or 502.

610. Psychological Theory in Educational Practice (3) I Major theories of psychological thought; strategies for utilizing such theories in educationally relevant research. P, 510.


614. Design of Instruction (3) II Historical and theoretical bases for developing instructional design; emphasis on relationship between learning theory and instructional design. P, 610.

615. Adult Learning and Development (3) I The psychodynamics of continuing development across the adult years; characteristics of adult learners. P, 510 or CR. (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.

630. 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.

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, 630.


646. Multidimensional Methods in Educational Research (3) I Provides an understanding of and facility with research application of multivariate correlational techniques, such as multiple regression, discriminant function, canonical correlation, and factory analysis. P, 640.

658. Theory of Measurement (3) II Advanced topics related to theoretical and practical issues in psychometrics. P, 558, 640 or CR.


671. Theories of Intellectual Assessment (3) I 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, 630; 671, 672b and 517, or CR.

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, 630; 671, 672b and 517, or CR.

693. Internship
a. Research and Evaluation (1 to 6) [Rpt. / 12 units] I II
b. College Teaching (1 to 6) [Rpt. / 12 units] I II
c. Learning and Development (1 to 6) [Rpt. / 12 units] I II
d. School Psychology (1 to 6) [Rpt. / 12 units] I II

694. Practicum
a. Research and Evaluation (3) [Rpt. / 1] I II
b. Learning and Development (3) [Rpt. / 1] I II
c. School Psychology (3) [Rpt. / 1] I II

695. Colloquium
a. Cognition (1 to 3) I II
b. Cross-Cultural Perspectives (1 to 3) I II
c. Human Development (1 to 3) I II
d. Instructional Technology (1 to 3) I II
e. Learning and Development (1 to 3) I II
f. Motivation for Learning (1 to 3) I II
g. Personality and Adjustment (1 to 3) I II
h. School Psychology (1 to 3) I II
j. Evaluation (1 to 3) I II (Identical with Ed.F.A. 695p)

696. Seminar
a. Research Design and Techniques (1 to 3) I II

ELECTRICAL AND COMPUTER ENGINEERING


Assistant Professors Robert A. Schowengerdt (*Arid Lands Resource Sciences*), 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.

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 also required to submit a thesis and pass a final oral examination. Under Plan "B," the student is required to complete at least six additional 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.

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 351b. (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 I 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 II Discrete-time systems and difference equations; time and frequency analysis, Z-transforms; sampling and data reconstruction; modern design of digital filters. P, 321b, Math. 322.

431. **Principles of Communication Systems** (3) GC 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 1984-85 (Identical with Met. 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 II Linear control system representation, analysis, stability and design. P, 321b.

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 II Theory and experiments in diffusion, oxidation, etc.; fabrication of an integrated circuit. (Identical with Met. 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.

459. **Laser Engineering** (3) GC I Introductory laser theory, device and systems engineering, including demonstrations and design problems of current importance. P, 351a, 381.

461. **Energy Conversion** (3) GC I Principles and operating characteristics of rotating machinery and electromagnetic transducers, single-phase and polyphase transformer operation, variable-frequency transformers. P, 321b, 381.

462. **Symmetrical Components** (3) GC I Three-phase circuit analysis; analysis of fault conditions in power systems. Field trip. P, 321b.


465. **Current Problems in Energy and Power** (1 to 4) GC II (Identical with Nu.E. 465)

467. **Solar Energy Engineering** (3) GC I (Identical with Nu.E. 467)
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)

Digital Logic Design (3) GC I 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)

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.

Computer Architecture (3) GC I (Identical with C.Sc. 476)

Environmental Impact of Energy-Related Systems (3) GC II (Identical with C.E. 477)

Microwave Measurements (3) GC II Measurement techniques and applications of devices used in microwave research. 2R, 3L. P. 381.

Electromagnetic Applications (3-3) GC Special functions, boundary valve problems, potential theory, transmission lines and in wave guides, resonant cavities, power flow in propagating waves, antennas and radiation. P. 381 or Phys. 415a.

Controlled Thermonuclear Energy (3-3) GC (Identical with Nu.E. 483a-483b)

Workshop
a. Energy Conversion Devices (3) [Rpt./1] GC II P. 461.

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.

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.

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.

Optimal Control of Dynamic Systems (3) II 1983-84 (Identical with A.M.E. 504)

Modern Control Theory (3) II 1984-85 (Identical with A.M.E. 505)

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.

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.

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.

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)

Image Processing: Devices, Systems and Applications (3) II 1983-84 (Identical with Opti. 533)

Advanced Electronic, Magnetic and Optical Materials (3) II 1984-85 (Identical with Met. 534)

Algebraic Coding Theory (3) II 1983-84 (Identical with Math. 539)


MOS Analog Integrated Circuits (3) I Terminal characteristics of NMOS and PMOS devices, simple gain stages, CMOS and NMOS operational amplifiers, voltage reference circuits, switches, switched-capacitor filters. P. 458.

Bipolar Analog Integrated Circuits (3) II Terminal characteristics of integrated bipolar devices, integrated components, simple gain stages, advanced biasing techniques, operational amplifiers, compensation, multipliers. P. 458.

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.
Active Linear Circuit Design (3) I 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.

General Physical Electronics (3) I Fundamentals of plasma, solid-state and optical electronics. Specific topics include lasers, thermoelectricity, solid-state and plasma devices.

Advanced Solar Engineering (3) I (Identical with Nu.E. 567)

Photovoltaic Cells, Arrays and Systems (3) I Photovoltaic fundamentals, silicon solar cells, thin film cells, concentrators, miscellaneous cells, solar cell arrays and systems, future terrestrial applications. (Identical with Nu.E. 568)

Energy Use: Analysis and Management (3) I (Identical with Nu.E. 569)

Digital Systems Design (3) I II 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)


Microprocessors, Minicomputers and Real-Time Distributed Processing (3) I II Real-time distributed processing using microprocessors and minicomputers. Applications to multiprocessor simulation, random-process measurements, and instrumentation. Multiprocessor sizing techniques. P. 475. (Identical with C.Sc. 573)

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.

Antenna Theory (3) I II 1983-84 Electromagnetic radiation and diffraction; dipoles, slots, open wave guides, and horns; apertures, reflectors, and arrays; mechanical and electronic scanning; applications to practical radar and communications problems. P. 581.

Atmospheric Electricity (3) I 1984-85 (Identical with Atmo. 589)

Information Theory and Coding (3) I II 1984-85 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)

Methods of Communication and Detection Theory and Signal Extraction (3) I II 1983-84 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.

Analysis and Design of Semiconductor Junction Devices (3) I II 1983-84 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.

Advanced Device Engineering (3) I 1983-84 Consideration of the design of devices: photoconduction, photovoltaic, tunneling, surface effects, junction avalanche, solid-state microwave generation, thermoelectric devices, and Hall effect.

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)

Principles of Atmospheric Remote Sensing (3) I II 1984-85 (Identical with Atmo. 683)

Inertial Confinement Controlled Fusion (3) I (Identical with Nu.E. 685)

Magnetic Confinement Controlled Fusion (3) I (Identical with Nu.E. 687)

Advanced Electromagnetics (3) I II 1984-85 Methods of solution of boundary value problems in electromagnetics; Green's function and eigen-function expansion techniques; approximation methods and numerical evaluation by computing machine. P. 502, 581.

Internship

c. Clinical Engineering (2 to 3) I II P, enrollment in clinical engr. option.
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.

403. Study of Exceptional Children (3) GC I II (Identical with Spec. 403)

406. English as a Second Language in Bilingual Education (3) GC I II (Identical with Eng. 408)

417. Visual and Auditory Aids in Teaching (3) GC I II (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)

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)

545. Multicultural Instructional Materials Development (2 to 4) S (Identical with S.Ed. 545)

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) I 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) I II S P, Ed.P. 301 or 310.
   f. Investigating the Environment (1 to 3) I II S Field trips. (Identical with S.Ed. 597f)
   n. Miscue Analysis in Teacher Education (2 to 3) II 1984-85
   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 Eng. 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)

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 1984-85 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 I I The elementary school curriculum and its relationships; basic theories and techniques of curriculum construction discussed, evaluated and applied. P. twelve units of elem.

624. **Mathematics Curriculum in the Elementary School** (3) I I I Emphasis on selection and placement of content, coordination of concepts with strategies of teaching, and selection and use of materials and resources. P. twelve units of elem.

625. **Developing the Language Arts Curriculum in the Elementary School** (3) I I I 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 I I 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.

628. **Curriculum in Early Childhood Education** (3) I I I Emphasis on selection of criteria to determine classroom organization, curriculum construction, and instructional programs. P. twelve units of elem.

629. **Investigations in Elementary Education** (3) I I I 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 1984-85 (Identical with S.Ed. 631)

632. **Diagnosis and Remediation in School Mathematics** (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 1983-84 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, Rdg. 633. (Identical with Rdg. 637)

638. **Written Language Development** (3) I I I 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] I I 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] I Contemporary research in language development from pre-school to adult as it relates to school language programs.

647. **The Principalship** (3) I I I (Identical with Ed.F.A. 647)

648. **The Superintendent** (3) I I I (Identical with Ed.F.A. 648)

695. **Colloquium**
   a. Elementary Education (1 to 4) I I I
   b. Early Childhood Education (1 to 4) I I I
   c. The Instructional Program (1 to 4) I I I (Identical with Ed.F.A. 695e, which is home)

697. **Workshop**
   b. Teacher Self-Appraisal (3) I I I (Identical with S.Ed. 697b, which is home)
   e. Future Studies: Elementary Curriculum (3) I
   f. Simulation and Gaming in the Classroom (3) I I I (Identical with S.Ed. 697f, which is home)
   h. Learning Centers in Elementary School Math (3) S
   n. Problems and Processes in Teacher Appraisal (1 to 3) I I I I I (Identical with S.Ed. 697n)

723. **Curriculum Theory and Evaluation** (3) I 1984-85 Current theoretical issues of curriculum objectives, design, change and evaluation.

794. **Practicum**
   b. Bilingual Education (3) [Rpt./2] (Identical with Ed.F.A. 794b, which is home)
   d. B
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.

Metallurgical Engineering
  metallurgy .................................................. 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.
  soil and water science ................................. M.S./Ph.D.

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. For further information contact the specific department.

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 technology 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. For further information contact Dr. K. C. Mylrea, Director, Clinical Engineering.
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.

MATERIALS ENGINEERING — This option is available in the Departments of Aerospace and Mechanical Engineering, Chemical Engineering, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Metallurgical Engineering, and Nuclear and Energy Engineering. Students interested in the materials problems of their major discipline may elect several courses within their various majors in order to pursue those interests. Those students who have a broader interest in materials in general should consult the interdisciplinary Materials Engineering Committee regarding an appropriate degree program.

RELIABILITY ENGINEERING — This option is available in the Department of Aerospace and Mechanical Engineering. It provides theoretical and practical tools — whereby the probability and capability of components, products, and systems to perform their required functions without failure in specified environments, for desired periods, as well as their maintainability, availability, and quality — can be predicted, designed in, tested, and demonstrated. Courses in this option are A.M.E. 406, 408, 412, 413a-413b, 506, 508, 512, 518, and 908.

SANITARY AND ENVIRONMENTAL ENGINEERING — This option is available in the Department of Civil Engineering and Engineering Mechanics. Students may choose to emphasize, at both the master’s and doctoral levels, the broad field of sanitary, environmental, and water resources engineering. Students with a background in science and engineering can expect stimulating challenges in this area of study, which is geared to the solution of many environmental problems associated with air, water, and health.

ENGINEERING MECHANICS

(See Civil Engineering and Engineering Mechanics)

ENGLISH

Professors Edgar A. Dryden, Head, Vance Bourjaily, J. Douglas Canfield, L. D. Clark, Sigmund Eisner, Dorothy V. Fuller (Emerita), Albert F. Gegenheimer, Frances Gillmor (Emerita), Byrd H. Granger (Emerita), Marie P. Hamilton (Emerita), Richard Hosley, Robert W. Houston, Billie Jo Andrew Inman, Carl F. Keppler (Emeritus), Carl H. Ketcham, John H. McElroy, Gerald M. McNiece, N. Scott Momaday, A. Laurence Muir (Emeritus), Harry F. Robins, Cecil Robinson, Paul Rosenblatt, Herbert Schneidau, Richard Shelton, Oliver F. Sigworth, Melvin T. Solve (Emeritus), Inez E. Thrift (Emerita), Peter Wild


Assistant Professors Jon Anderson, Carl Berkhout, Dhira Mahoney, Patrick O’Donnell, Jonathan Penner, Duane Roen, Alice M. Senob (Emerita), Leslie Marmon Silko, Carolyn Jan Swearingen, Charlotte Thompson, Thomas Willard, Jean Zukowski/Faust

Lecturers Edward Abbey, Christopher Carroll, Dorothy N. Fuller, Ruth M. B. Gardner, Evelyn J. Kirmse (Emerita), Gloria I. Morton, Tom C. Taylor
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 24 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 and that 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)


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.
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)

411. **Teaching of Literature** (3) GC I II Theory and practice of teaching literature, with intensive study of genres and works commonly taught in secondary schools. P. nine units of lit. (Identical with S.Ed. 411)

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 Writing in Forms** (3) GC II Explores English prosody through discussing and writing major forms; research paper. Open to creative writing majors only. P. 309.

414. **Literature and Writing in the Elementary School** (3) GC II Critical approaches to children's literature; theoretical and practical preparation for teaching writing. P. 207, and six units of upper-division lit.

415. **General Linguistics** (3) GC I General survey of the principles and history of modern general linguistics.

438. **The Indian in the Literature of the Americas** (3) GC II 1984-85 Studies of works by and about Indians published throughout the Americas. (Identical with A.In.S. 438)

442. **Oral Tradition and Folk Literature in the Americas** (3) GC II 1983-84 Folklore of the Americas: English, Scottish, Spanish, Portuguese, French, African, Indian; conducted in Engl. and other languages.

449a-449b. **Folklore** (3-3) GC 449a: Customs and beliefs of birth, initiation, marriage, death material culture, art, medicine, the supernatural, and the calendar. 449b: Myth, tales, epic, legend, drama, song, dance, music, riddles, proverbs, and other speech forms. (449a is identical with A.In.S. 449a and Anth. 449a)

504. **Linguistics and the Study of Literature** (3) GC II 1984-85 (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

527a-527b. **Studies in Medieval Language and Literature** (3-3) 527a: Old English. (Identical with Ger. 527a). 527b: Middle English.

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

557a-557b. **Studies in Twentieth-Century British Literature** (3-3) 557a: Modern British literature. 557b: Contemporary British literature.

561. **History of Children's Literature** (3) II (Identical with Li.S. 561)

565a-565b. **Studies in American Literature to 1900** (3-3) 565a: To 1850. 565b: 1850-1900.

596. Seminar
  a. Medieval Literature (3) [Rpt.] I II
  b. Renaissance Literature (3) [Rpt.] I II
  c. Restoration and Eighteenth-Century Literature (3) [Rpt.] I II
  d. Nineteenth-Century British Literature (3) [Rpt.] I II
  e. Twentieth-Century British Literature (3) [Rpt.] I II
  f. American Literature (3) [Rpt.] I II
  g. Comparative Literature (3) [Rpt.] I II
  h. Modern Literature (3) [Rpt.] I II Open to creative writing majors only.
  i. Germanic Linguistics (3) [Rpt.] I II (Identical with Ger. 596i)
  j. Linguistics for ESL (3) [Rpt.] I II
  k. Methods and Materials of Literary Research (3) [Rpt.] I II
  l. Theories of Criticism (3) [Rpt.] I II
  m. Studies in the Oral Tradition (3) [Rpt./9 units] I II (Identical with A.In.S. 596m)

597. Workshop
  o. The Teaching of English (3) I II S [Rpt.] (Identical with S.Ed. 597o)
  w. Southern Arizona Writing Project (3-9) [Rpt./12 units] I II S (Identical with S.Ed. 597w, which is home)

604. Writing Project in Fiction (3 to 6) [Rpt.] I II For M.F.A. candidates working on the book-length writing project in fiction.

609. Writing Project in Poetry (3 to 6) [Rpt.] I II For M.F.A. candidates working on the book-length writing project in poetry.

612. English Grammar for ESL (3) I Problems analysis of ESL: remedial ESL composition. (Identical with S.Ed. 612)

613. Teaching of ESL (3) I 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)

693. Internship

696. Seminar
  b. Linguistics (2 to 4) I II (Identical with Ger. 696b, which is home)
  c. Folklore (2 to 4) I II (Identical with Ger. 696c, which is home)

**ENGLISH AS A SECOND LANGUAGE**
*(See English)*

**ENGLISH EDUCATION**
*(See English)*

**ENTOMOLOGY**

Professors George W. Ware, Head, Larry A. Crowder, Paul D. Gerhardt (Emeritus), Roger T. Huber, Leon Moore, William L. Nutting, Donald M. Tuttle, Theo F. Watson, Floyd G. Werner

Assistant Professors David N. Byrne, Robert L. Smith

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in entomology. Concentrations are available in acarology, apiculture, behavior, biological control, bionomics, ecology, host plant resistance, insect pest management, morphology, physiology, range/forest, taxonomy, toxicology, and urban, veterinary, and public health entomology.
Admission requirements include, generally, 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 predict the 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, physiology, ecology, and insecticides. A thesis is ordinarily required. The doctoral program requires, in addition to the requirements for the master’s degree, courses in biochemistry, computer programming, and statistics, and the equivalent of one semester of teaching experience.


402. Introduction to Pesticides and Their Use (2) GC II (Identical with Pl.P. 402)

403. Parasites of Domestic Animals (2) GC I (Identical with V.Sc. 403)

404. Insect Morphology (4) GC I 1984-85 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 1984-85 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 bioc. Crowder

411. Applied Insect Ecology (3) GC I Population dynamics of agriculturally important insects, with emphasis on sampling, phenology, and key factor analysis of regulating mechanisms. 2R, 3L. Field trips. P, three units of stat. Huber

415. Agricultural Entomology (4) GC I Nature of injury, life history, habits, and control of major agricultural insect pests in Arizona; insecticides and implications of use. 3R, 3L, P, 151 or 201R.

420. Urban Entomology (3) GC II 1983-84 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

425. Insect Pest Management (3) GC II Concepts and methods of pest management; the integration of all control methods compatible with optimum crop production practices. 2R, 3L. Field trips. P, 415. Watson/Moore

502. Acarology (2) I 1984-85 A survey of the Acarina, or mites, followed by more detailed study of the recognition and biology of plant feeding forms. 1R, 3L. Tuttle

506. Plant Resistance to Insects (2) II 1984-85 Insect-plant relationships pertaining to resistance and related factors in crop plants; methods, problems, and research techniques involved in developing resistant varieties. (Identical with Pl.S. 506) Nielsen

508. Insect Toxicology (3) III 1983-84 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) Crowder/Ware

512. Insect Behavior (3) III 1983-84 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

514. Biological Control (3) I 1984-85 Principles of the biological control of arthropods, with emphasis on their application to agricultural entomology. Watson

516. Applied Insect Taxonomy (4) I 1983-84 Principles and methods in the development of a classification of insects in limited areas and habitats, with emphasis on groups of economic importance. 3R, 3L. Field trips. Werner

578. Environmental Toxicology (3) I (Identical with Tox. 576)

696. Seminar
   a. Entomology (1) [Rpt./6] I II
FINANCE AND REAL ESTATE

Professors Clark A. Hawkins, Head, Gerald O. Bierwag, Nestor R. Roos, James E. Wert
Associate Professors Erich K. Bleck, John T. Emery, Joseph S. Gerber, Eric Sorensen
Lecturers Thomas C. Moses, Sanders K. Solot, Robert Ash Wallace

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 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 II Current practices and techniques of evaluating common stocks, bonds, stock options and warrants. P, 421.
431. Financial Intermediaries (3) GC 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 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.
461. Real Estate Law (3) GC II Principal areas of the law of real estate. P, 261;
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.
471. Policy Formulation and the Finance Function (3) GC II Integrative course utilizing the case study approach and focusing on the financial impact of marketing and production strategies. P, 412, Mgmt. 305, 373, Mktg. 361.
486a-486b. Occupational Safety and Health (3-3) GC I (Identical with O.S.H. 486a-486b)
511. Business Finance (3) II 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. P, Acct. 550.
512. Advanced Corporation Finance (3) II Theory and practice of capital investment decisions in the corporation, including replacement, refunding, risk and uncertainty. P, 412 or 511.
513. Theory of Finance (3) II Theoretical models pertaining to financial decisions. P, 412 or 511.
521. Portfolio Management (3) I Portfolio theory and portfolio choice; the options market; investor risk behavior and strategy. P, 421.
522. Advanced Securities Analysis (3) II Examination of securities risk, return, and price behavior in competitive markets. P, 421 or 521.
532. Financial Futures and Options (3) II Design and trading of interest rate futures and options. Examination of their use in hedging, speculating, arbitraging, and their regulation. P, 421 or 521.

555. Advanced Safety Management (3) II Relating safety management to modern motivation theories; coordinating control of environment and behavior; interaction of unions, business, government, and other societal institutions. P, 455.

556. Safety Law (3) II 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.

557. Safety and Institutional Policy (3) S Occupational safety problems; society’s organization of safety; early legislation; successes and failures of early safety efforts; consumerism; institutions bearing on safety problems. P, 555.

561. Advanced Subjects in Real Estate (3) I Syndication, feasibility studies, tax-free exchanges, and advanced appraising. P, 361.


696. 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 SCIENCES
(See Nutrition and Food Science and Home Economics)

FRENCH AND ITALIAN

Professors Jean-Jacques Demorest, Head, Guido Capponi, Frank M. Chambers (Emeritus), Loyal Gryting (Emeritus), Charles I. Rosenberg

Associate Professors Edward G. Brown, Ingeborg M. Kohn, Henri Servin, Gianni Spera

Lecturers Gerard Agnieray, John L. Gesell, Jean Goetinck, Annamaria Kelly

The department offers programs leading to the Master of Arts with majors in French and Romance languages, and the Doctor of Philosophy degree 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 cooperates actively 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.
MASTER OF ARTS (Major in Romance languages) — Students must complete 39 units of course work in two of the following languages: French, Italian, Portuguese, and Spanish (21 units in one language and 18 in the other).

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 1983-84 403a: Early Renaissance, Reformation, Rabelais, the Pleiade. 403b: The Humanists, Montaigne, D'Aubigne, the drama. P, 201b.


414. Teaching of Modern Languages (3) GC I II (Identical with S.Ed. 414)

415. Stylistics (3) GC I Principles of stylistics, with exercises in literary translation and original writing. P, 375b.

422. Introduction to Romance Philology (3) GC I 1984-85 (Identical with Span. 422)

430a-430b. French Civilization (3-3) GC Historical, social, economic, literary, and artistic elements in the development of the French nation. P, 201b.


450. French Literature of Black Africa and the West Indies (3) GC I 1984-85 P, 201b. (Identical with Bl.S. 450)

451. Literature of the Fantastique (3) GC II 1984-85 Study of certain elements 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 1984-85 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 English; grad. students will do additional work in composition and stylistics. P, 201b.

472. French Phonetics (2) GC II 1983-84 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 1983-84

511. Approaches to French Literature (3) II 1983-84 Methods of criticism and techniques of literary analysis.


557. Rousseau (3) II 1984-85 Rousseau's political thought; his ideas concerning education; The Confessions; the beginning of Romanticism.

558. Realism and Naturalism in the Novel (3) I 1983-84 Flaubert, Zola, Maupassant, etc.
559. **New Theatre** (3) I 1984-85 Ionesco, Beckett, Adamov, Arrabal, 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
   c. Old French Literature (3) I II
d. 16th Century (3) I II
e. 17th Century (3) I II
   f. 18th Century (3) I II
g. 19th Century (3) I II
   h. 20th Century (3) I II

**Italian**

400a-400b-400c. **Survey of Italian Literature** (3-3-3) GC Representative masterpieces of the Italian Renaissance in translation. Will not count toward fulfillment of the language requirement for the major or minor. P. 201b.

405a-405b. **Advanced Composition and Conversation** (3-3) GC P, 201b.

406a-406b. **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.

422. **Introduction to Romance Philology** (3) GC I 1984-85 (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

**Romance Languages**

422. **Introduction to Romance Philology** (3) GC I 1984-85 (Identical with Span. 422)

429. **Pedagogical Linguistics: Applied Linguistics for Language Teachers** (3) GC II (Identical with Or. S. 429)

**GENERAL BIOLOGY**

Professors Joseph T. Bagnara, Head, Mac E. Hadley, Robert M. Harris, Albert R. Mead, Walter B. Miller, Newell A. Younggren

Associate Professors Russell Davis, Robert S. Melior, Willard Van Asdall

Assistant Professor Denis J. Meerdink

Lecturers C. William Gaddis, Donald B. Sayner

The department offers graduate programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in general biology. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in general biology. For further information concerning this degree see **Requirements for Master's Degrees/Master of Education** elsewhere in this catalog.

Applicants for admission should be prepared in chemistry, physics, and mathematics and must submit scores on the aptitude and advanced tests of the Graduate Record Examination. All applicants must communicate directly with the department regarding other requirements for admission. The application files of students desiring financial assistance should be completed by June 1. The final deadline for the completion of all application files is June 15 for fall semester admission.

Students are normally expected to specialize in areas of interest to members of the faculty. These would include, but would not be restricted to, botany, ethnobotany, genetics, invertebrate zoology, parasitology, and physiology. A listing of the faculty of the department and their research interests can be obtained from the department on request. Students desiring
to major in wildlife and fisheries science should apply to the School of Renewable Natural Resources.

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** (2) GC II (Identical with Hist. 402)

403. **Techniques of Biological Literature** (2) GC II Selecting the research problem, sources of reference, recording and assembling data, preparation of the scientific report, publication procedure.

410a. **Advanced Cell Biology** (3) GC II (Identical with Cell. 410a)

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. (Identical with Ecol. 412)

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 and Micr. 418a-418b)

428R. **Advanced Microbial Genetics** (3) GC II (Identical with Cell. 428R)

428L. **Advanced Microbial Genetics Laboratory** (2) GC II (Identical with Cell. 428L)

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, and Micr. 433)

436. **Plant Ecology** (4) GC I Plants in relation to their environment; plant communities, and factors affecting the distribution of plants. 3R, 3L. All-day field trips and/or labs. on six Saturdays. (Identical with Ecol. 436)

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. (Identical with Ecol. 437)

456. **Developmental Biology** (4) GC (Identical with Cell. 456)

457. **Experiments in Developmental Biology** (4) GC (Identical with Cell. 457)

458. **Comparative Vertebrate Anatomy** (4) GC II (Identical with V.Sc. 458)

459. **Comparative Vertebrate Histology** (4) GC I (Identical with V.Sc. 459)

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 Cell. 464aR-464bR and Tox. 464aR-464bR)


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

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

474R. **Ethnobotany** (3) GC II Survey, with emphasis on cultural uses of plants, both past and present; theories and techniques of archaeological and ethological identification of plant materials. P, eight units of bio. or anth. (Identical with Anth. 474R)

474L. **Ethnobotany Laboratory** (1) GC II Field-lab. course treating sampling, processing, storage, and identification techniques and interpretation in ethnobotany. Field trips. P, eight units of bio. or anth. (Identical with Anth. 474L)

478. **Origins and Development of Cultivated Plants** (3) GC I Evaluation of theories of origins and early development of cultivated plants in general, with special attention given to important crop plants and cultivars whose origins are more firmly established. Three-day field trip. P, 321.

480. **Invertebrate Zoology** (4) GC I Comparative morphology, physiology, and ecology of invertebrates. 2R, 6L. Field trips. P, 104. (Identical with Ecol. 480)

489. **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 Ecol. 489, Micr. 489 and V.Sc. 489)

495. **Colloquium**
   a. Problems in Plant Ecology (2) [Rpt./2] GC I (Identical with Ecol. 495a, which is home.)

503. **Zoological Taxonomy** (1) I Nomenclatural procedure, taxonomic problems, synonymy, homonymy, priority, availability, validity, describing the new taxon.

GENETICS

Committee on Genetics (Graduate)

Professors Robert M. Harris (General Biology), Chairperson, William P. Bemis (Plant Sciences), Harris Bernstein (Microbiology), John R. Davis (Pathology), John E. Endrizzi (Plant Sciences), William B. Heed (Ecology and Evolutionary Biology), Frank R. H. Katterman (Plant Sciences), Robert G. McDaniel (Plant Sciences), Neil H. Mendelson (Cellular and Developmental Biology), David Mount (Microbiology), Robert T. Ramage (Plant Sciences), Donald E. Ray (Animal Sciences), Associate Professors Richard E. Michod (Ecology and Evolutionary Biology), Nobuyoshi Shimizu (Cellular and Developmental Biology), Oscar G. Ward (Ecology and Evolutionary Biology), Stephen Zegura (Anthropology)

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. 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 Agris. 539, 540; Anth. 666; Bioc. 569a-569b; Cell. 410a-410b, 562, 612; Chem. 460, 480a-480b, 565a-565b; Ecoc. 523, 525, 526; G.Bio. 522; Micr. 428R, 428L, 527; M.Micr. 570, 580; N.F.S. 617, 620; P.I.S. 516, 627, 632, 634, 635; S.I.E. 470.

520. History of Genetics (1) 1984-85 Experiments and discoveries which have led to the present state of knowledge in the various areas of genetics. P, G.Bio. 320.

595. Colloquium
   a. Genetics (1) [Rpt.] II

620. 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, G.Bio. 320 or 321. (Identical with Ecol. 620) Ward

670. Recent Advances in Genetics (2) I Recent advances in the field of genetics. (Identical with G.Bio. 670 and Micr. 670)
GEOGRAPHY AND REGIONAL DEVELOPMENT

Professors Lay J. Gibson, Head, Melvin E. Hecht, Leland R. Pederson, Richard W. Reeves, Thomas F. Saarinen, Dan Stanislawski (Emeritus), Andrew W. Wilson (Emeritus)
Associate Professor D. Robert Altschul
Assistant Professors Charles F. Hutchinson, Gordon F. Mulligan, 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. Doctoral-level work in regional development is available through the Committee on Business Administration. For further information concerning this degree program see Business Administration elsewhere in this catalog.

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, 501, 502, and 589 during the first year in residence. The remainder of the program is selected, with the approval of an adviser, from geography and appropriate supporting disciplines. Students are urged to write a thesis, for which a maximum of six units may be earned, and those intending to continue to the doctorate should do so. Students electing the thesis option must pass a final oral examination. Those electing the nonthesis 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.

Students working toward the Doctor of Philosophy degree must, in addition to the requirements for the Master of Arts degree, complete eighteen units in geography (exclusive of the dissertation) including 557 and no fewer than twelve additional units of 500- or 600-level courses. 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 cultural, economic, historical, physical, and urban geography. 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 French or German, or approved language and completion of an eleven-unit sequence in statistics to be prescribed by the departmental faculty. The minor or minors may not be within the department and 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.

401a-401b. Water Resource Management (3-3) GC (Identical with W.R.A. 401a-401b)

407. The American Landscape (3) GC II Origin and character of the visual aspects of places viewed individually and regionally; changes in habitat, vernacular structures, landscaping, townscapes, countrysides and special features. Field trips.

408. Arizona and the Southwest (3) GC I II The changing character of the land and man's occupancy of it, with emphasis on Arizona; historically and problem oriented. Field trip.

411. Middle America (3) GC II Land, man, and culture in the major natural and cultural regions of Mexico, Central America, and West Indies. Pederson
412. South America (3) GC I Physical and cultural bases of South America's geographic patterns, with emphasis on human settlement and problems of resource development. Pederson

413. Africa (3) GC II Physical and human bases of regional contrasts, with emphasis on tropical environmental systems and changing patterns of resource utilization. Altschul

414. Rural Area Development (3) GC I (Identical with A.Ec. 414)

453. Industrial Location Analysis (3) GC II Geographic distribution of industrial location; location factors and case studies; scale and the modern corporation; geographic inequalities and public policy. Mulligan

456. Urban Geography (3) GC I 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. Mulligan

457. Statistical Techniques in Geography and Planning (3) GC I Methods of gathering and analyzing data for the solution of geographical, urban, and regional planning problems, with emphasis on quantitative and statistical techniques used in spatial analysis and cartography, on the one hand, and program planning, on the other. (Identical with U.Pl. 457)

459. Topics in Economic Geography of the Middle East (3) GC II (Identical with Or.S. 459)

461. Population and Resources (3) GC I Estimates of present and potential world population; distribution and methods of conserving important resources. Field trips. (Identical with W.R.A. 461)

463. Physical Aspects of Arid Lands (3) GC II 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

464. The Arid and Semiarid Lands (3) GC I Past, present and future of settlement and resource utilization in the world's arid lands; spatial interrelationships of environmental, demographic, socioeconomic and political systems. Altschul

469. Geography of the Middle East (3) GC I (Identical with Or.S. 469)

471. Problems in Regional Development (3) GC II Regional inventories and methods of analysis; development problems, policies and strategies; generation, implementation, and evaluation of development programs; case studies. P. 371 or Fin. 261 or A.Ec. 414. (Identical with A.Ec. 471) Plane/Gibson

481. Computer Cartography (3) GC II Introduction to the use of computers for map production, with emphasis on cartographic principles and practical experience with several user-oriented mapping programs. Reeves

483. Geographic Applications of Remote Sensing (3) GC II 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. Hutchinson

485. Geography Summer Field Camp (6) [Rpt./2] GC S Physical and cultural problems in geography studied at first hand. Fee, $300. P, six units of geog. Gibson/Reeves

501. Advanced Physical Geography (3) I Extensive reading in important journal articles and other original publications. Designed for M.A. candidates, to be taken during their first or second semester, to provide a comprehensive foundation. P. 103b; twelve additional units of geog. Reeves

502. Advanced Cultural Geography (3) II Similar in scope and method to 501, but in the field of cultural geography. P. 102a-102b; twelve additional units of geog.

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. 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.

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. Saarinen

562. Paleoeocology and Man (3) I (Identical with Geos. 562)

563. Perception of Environment (3) I I Examination of interdisciplinary research on environmental perception; consideration of social and behavioral variables at all scales of environmental perception and planning. (Identical with U.Pl. 563) Saarinen

589. History of Geographic Thought (3) I History of geographic philosophy and methodology. P, fifteen units of geog. Pederson

596. Seminar
  u. Interdisciplinary Environment-Behavior-Design (3) I (Identical with Idis. 596u, which is home)

609. Problems of Urban Change (3) II (Identical with U.Pl. 609)
696. Seminar
   a. Economic Geography (3) II
   b. Cultural Geography (3) II
   c. Physical Geography (3) II
   d. Historical Geography (3) III
   e. Area Study (3) I II

GEOLOGICAL ENGINEERING
(See Mining and Geological Engineering)

GEOSCIENCES

Professors George H. Davis, Head, John W. Anthony, Victor R. Baker, William B. Bull, Peter J. Coney, Paul E. Damon, 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. McCulloough, Jr., Bartholomew S. Nagy, Denis L. Norton, Hugh Odishaw, Joseph F. Schreiber, Jr., George Gaylord Simpson (Emeritus), Terah L. Smiley, Marvin A. Stokes (Laboratory of Tree-Ring Research), John S. Sumner (Emeritus), Spencer R. Tittley, James R. Wait (Electrical and Computer Engineering)

Associate Professors Robert F. Butler, Karl W. Flessa, Jibanmitra Ganguly, Austin Long, Timothy P. Loomis, H. J. Melosh (Planetary Sciences), Charles W. Stockton (Laboratory of Tree-Ring Research)

Assistant Professors Owen K. Davis, Christopher J. Eastoe, Susan M. Kidwell, Randall M. Richardson, Marc L. Sbar

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, 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 select, from the department's curriculum options, a concentration in one or more of the following areas:

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; volcanogenic ore systems.
Geophysics — Seismology; inverse theory; potential field; 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 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 early history of life.

Planetary Geology — A joint program of 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; paleoecology and evolution.

Tectonics — Structural geology; regional tectonics; tectonic geomorphology; sedimentary tectonics; tectonophysics; geochronology; tectonic implications of paleomagnetism.

401. Environmental Education (3) GC I 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) Martin

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 or Ecol. 102. Lindsay

410. Mammalian Phylogeny and Evolution (3) GC II 1984-85 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 Processes and tectonic settings of sedimentation; field and lab. study of sedimentary texture and structures; sediment deposition in nonmarine, transitional, and marine environments. 2R, 3L. Field trips. P, 225, 302. Dickinson


419. Physics of the Earth (3) GC I Introduction to the structure and dynamics of the Earth using seismology, heat flow, gravity and magnetics; introduction to plate tectonics. P, Phys. 103b, 116. (Identical with Pty.S. 419) Richardson/Butler

420. Geophysical Exploration (4) GC I Principles of geophysical methods used in the location and evaluation of mineral, water, geothermal and petroleum occurrences and interpretation of geophysical data. 3R, 3L. P, Phys. 103b, 116, or 121. (Identical with G.En. 420)

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

425. Methods in X-Ray Analysis (3) GC II Generation and properties of X rays; their application to X-ray diffraction techniques of the study of minerals and to chemical analytical methods based on X-ray fluorescence. 2R, 3L. P, Phys. 121. Anthony


435. **Hydrogeology** (3) GC I II (Identical with Hydr. 435)


439. **Biogeography** (3) GC I (Identical with Ecol. 438)

443. **Industrial Minerals and Rocks** (3) GC I 1984-85 Geology, origin, mode of occurrence, and methods of evaluation of nonmetallic mineral deposits. 2R, 3L, P, 303. Guilbert

450. **Geomorphology** (4) GC I Concepts of landform development, with emphasis on fluvial processes and environmental applications. 3R, 3L. Field trips. P, 101a or 151. Bäker

454. **Glacial and Quaternary Geology** (3) GC II Glacial processes, landforms, and deposits. Physical aspects of Quaternary paleoenvironmental change and effects on fluvial, eolian, lacustrine, weathering, and mass movement processes. P, 101b or 151. Bäker

457. **Principles of Geochemistry I** (3) GC I Equilibrium and kinetic chemical processes producing soils, natural waters, and chemical sediments. P, 101a or 151, 101b; Chem. 103b, 104b. Long

458. **Principles of Geochemistry II** (3) GC II Nuclear systematics and thermodynamics with applications in high temperature geochemistry. P, 101a or 151, 101b; Chem. 103b, 104b.

462. **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) O. Davis

464a-464b. **Introduction to Dendrochronology** (3-3) GC Survey of tree-ring methods, theory and applications to archaeological dating, modern chronology and dendroclimatology. 2R, 3L. Field trips. (Identical with Anth. 464a-464b and Ws.M. 464a-464b) Stokes

470. **Introduction to Paleobotany** (3) GC II Paleontologic approaches to the reconstruction of ancient environments, populations and communities. Evolution of communities through geologic time. 2R, 3L. Field trips. P, 225, 302. Fessas

475. **Cenozoic Mammalian Faunas** (3) GC II 1983-84 Continental Cenozoic stratigraphy and mammalian biochronology of North America and other continents. 2R, 3L. Field trips. P, 409. Lindsay

504. **Geology of Arizona** (3 to 4) I Systematic coverage of Basin and Range province and Colorado Plateau geology as part of the Southern Cordillera, with emphasis on significant problems. Field trips. Consult dept. before enrolling for three unit option. Damon

505. **Evidences of Past Climates** (3) II Deductive factors used to determine past climates; interrelation between these factors and paleogeography. Smiley

507. **Applied Multispectral Imagery** (3) II (Identical with G.En. 507)

509a-509b. **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

514. **Late Quaternary Geology** (3) I How geologic processes affect environment; how late Pleistocene and Holocene paleoenvironments and geochronology have been inferred from stratigraphic records and geomorphology at key localities and archaeological sites. Field trips. P, 101b. (Identical with Anth. 514) Haynes

520. **Meteorites** (3) II 1984-85 (Identical with Pty.S. 520)

521. **Analysis of Regional Geologic Structure** (3) I Systematic analysis of the sum total of geologic structures within regional terranes. Emphasis on the strain significance of regional structure. Field trip. 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 regimes and their kinematics, economic aspects of 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 1984-85 Nuclear phenomena applied to the solution of geologic problems, with emphasis on radio isotope dating and isotope petrology. (Identical with Pty.S. 528) Damon

529. Atomic Structure of Minerals (2) I Physical and chemical properties of crystalline solids examined with regard to their internal structures; special emphasis on minerals. P, 405. Anthony

535. Aquifer Mechanics (3) I (Identical with Hydr. 535)

536. Development of Groundwater Resources (3) II (Identical with Hydr. 536)

537. Advanced Ecology (2) II (Identical with Ecol. 537)

541. Soil Genesis (3) II (Identical with S.W.E. 541)

542. Ore Deposit Petrology (3) II 1984-85 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. Guilbert/Tilley

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 1984-85 (Identical with Pty. S. 554)

557. Quantitative Methods in Dendrochronology (3) I 1984-85 Processing and evaluation of tree-ring data, with applications in climatology, ecology, hydrology, and archaeology. 2R, 3L, P, 464a-464b, Agri. 539. (Identical with Ws.M. 557) LaMarche


561. Pale-Indian Geochronology (3) II (Identical with Anth. 561)

562. Paleocology 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) 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 1984-85 Linear inverse theory, including generalized and stochastic methods, with application to geophysical problems in seismology, gravity, geomagnetics and other areas. P, Math. 422b. (Identical with Pty.S. 567) Richardson

571. Constitution and Evolution of the Terrestrial Planets (3) I 1983-84 (Identical with Pty.S. 571)


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, thermal, and diagenetic evolution of sedimentary basins in various plate tectonic settings, with emphasis on exploration for hydrocarbon resources. Field trips. 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. Paleocoeology-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

650. Field Studies in Geomorphology (3) II 1983-84 Application of quantitative methods to field problems. 2R, 3L. Field trips (includes spring break field trip). P, 450. *Bull*

651. Tectonic and Climatic Geomorphology (3) II 1984-85 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 David J. Woloshin, *Head*, Jean R. Beck (*Emeritus*), Max Dufner, Renate A. Schulz
Associate Professors David H. Chisholm, Dennis I. Greene, Richard C. Helt, Babette Luz (*Emerita*), Roland Richter
Assistant Professor Pack Carnes
Lecturer John R. Wendel

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.

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-479b 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 German.
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 Eng. P, six units of upper-division Ger. Carnes/Greene

405. History of the English Language (3) GC I II (Identical with Eng. 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, with collateral reading in Eng. and Ger. P, six units of upper-division Ger. Dufner/Richter

425b. German Art (3) GC I 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 Eng. Readings in Ger. for Ger. majors. (Identical with Eng. 469a-469b) Carnes

475a-475b. Advanced Grammar and Stylistics (3-3) GC Practical training in written Ger. through the study of more complex refinements of German grammar and style, as found in representative documents. P, 315b. 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. Schulz

496. Proseminar
   a. Translation (3) [Rpt./2] GC I II P, 315b.
   b. German Lyric Verse from the 16th to the 20th Century (3-3) 1984-85 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. Chisholm

503. Eighteenth-Century German Literature (3) I II 1983-84 Klopstock, Lessing, Wieland, Goethe, Schiller, Holderlin and other authors. P, six units of upper-division Ger. Dufner

505a-505b. Nineteenth-Century German Literature (3-3) 1984-85 A survey. P, six units of upper-division Ger. 505a is not prerequisite to 505b. Richter/Helt

507. Goethe's Faust (3) I II 1984-85 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) 1983-84 Class and collateral reading, lectures and reports, partly in Ger. P, six units of upper-division Ger. 509a is not prerequisite to 509b. Greene

511a-511b. Middle High German (3-3) 1984-85 Brief study of Middle High German grammar; selective readings from representative literary works of the period. P, 302b, 315b. Carnes

520a-520b. History of the German Language (3-3) 1983-84 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 Eng. 520a-520b)

525. Beowulf (3) I 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.] I 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 problems in Germanics.

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), Chairperson, Herbert E. Carter (Biochemistry), Victor A. Christopherson (Home Economics), William F. Denny (Internal Medicine), Louis J. Kettel (Internal Medicine), Dorothy I. Marquart (Psychology), Jack H. Wilmore (Physical Education)

Associate Professors Theodore H. Koff (Public Policy, Planning and Administration), Jessie V. Pergrin (Nursing), Roy G. Spece, Jr. (Law)

Assistant Professors J. Lyle Bootman (Pharmacy Practice), William L. Roberts (Family and Community Medicine)

Director of Interdisciplinary Programs John R. Edwards, Jr.

Because of its multidisciplinary nature, courses in gerontology are 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 pursuing gerontological studies. The Committee does not offer a graduate major or minor at present. Students interested in incorporating an emphasis in gerontology into their chosen minor should consult their departmental advisers and the Coordinator of the Committee on Gerontology. Courses identified as having content which deals specifically with the elderly and with aging processes include: Anth. 470a-470b; Coun. 570; Gero. 694, 695a; C.D.F.R. 413; C.S. 436; Law 656; Med. 596bb; Nurs. 589, 600a-600b-600c; N.F.S. 538, 638; Ph.Ed. 422; Ph.Pr. 448; Psyc. 421, 435; P.P.P.A. 454, 466, 595c, 595d, 662, 693f, 696e; Rhab. 455; Soc. 406; Sp.H. 484, 554, 596e. In addition, graduate work with a strong gerontological focus is available in long-term care administration (M.P.A.) and gerontological nursing (M.S.).

The Committee offers formal recognition for a gerontological emphasis through an 18-unit structured course of graduate study designed primarily for individuals planning to enter or to continue in a profession which involves provision of services and/or administration of programs for aging.

Students wishing further information on study in gerontology should contact the Coordinator, Committee on Gerontology, Anthropology 316.

695. Colloquium
   a. Research in Gerontology (1) I II

GRADUATE LIBRARY SCHOOL
(See Library Science)

HEALTH EDUCATION
(See Health-Related Professions)

HEALTH-RELATED PROFESSIONS

Professors William H. King, David Wayne Smith
Associate Professors Sue Criswell, Kam Nasser, Pierre DeCouffe
Assistant Professors Lucinda A. Alibrandi, Paul R. Marques
Lecturers Marilyn Bever, Judith Nevin, Sr. Joann Thomas, Diane Woodworth, Deborah Wyckoff

The School of Health-Related Professions, an integral part of the Arizona Health Sciences Center, presently offers the Master of Science degree with a major in addiction studies and the Master of Education degree with a major in health education.
**Degrees**

**MASTER OF SCIENCE** — The major in addiction studies requires a minimum of 48 units and a final written and oral examination. Four specializations are available. The specialization in criminal justice prepares students for positions within the criminal justice system dealing with drug- and alcohol-related problems and emphasizes the rehabilitation process. The community resource specialization prepares students for administration of community agencies. The specialization in employee assistance prepares students for work in industrial and professional organizations with employees whose work has deteriorated because of chemical abuse. The substance abuse research specialization prepares students with undergraduate science degrees for careers in drug and alcohol research and education. For further information on courses required for each of these specializations, contact the School of Health-Related Professions.

**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 Hth. 430, 431, 432, 433, 434, 435, 436, 437, 440, 475, 496a, 599, and 699) and twelve units of education courses. 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.

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**Health-Related Professions**

460. **Introduction to Epidemiology** (3) GC I II Introduction to the purposes, principles, and methods of epidemiology.

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.

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**Addiction Studies**

405. **Introduction to Addiction Studies** (3) GC I II S Biological, medical, pharmacological, sociological and psychological aspects of addiction and addictive substances.

505. **Psychosocial Perspectives of Addictions** (3) I II Factors of addiction considered from psychosocial, cultural, and anthropological perspectives.

506. **Biomedical Perspectives on Psychoactive Drug Use** (3) I II Overview of psychophysiology and pharmacology relevant to abused drugs; discussion of health and illness relevant to drug use.

509R. **Applied Management Treatment Strategies** (3) I Consideration of project and program planning, development, administration and grant writing. P, 505, 506 or CR.

509L. **Applied Management Treatment Laboratory** (1) I

519. **Research Design in Addictions** (2) I II P, 505, 506.

596. **Seminar**
   a. Psychosocial Research Issues in Addictions (2) I II P, CR 505.
   b. Biomedical Issues (2) I II P, CR 506.

694. **Practicum**
   a. Agency Visits (3) I Field trips.
   c. Agency Work II (2) I II S P, 694b.
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 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, community, voluntary, public and international health organizations.

448. **Perspectives in Geriatrics for Health Professionals** (3) GC II (Identical with Ph.Pr. 448)

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 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 I 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, Chem. 322, 323, O.S.H. 486a, CR Chem. 324.
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.

630. **Continuing Education** (3) I 1983-84 Development and future trends in continuing education programs in higher education; cultural, social and economic factors affecting continuing education; characteristics of students and programs.

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. Field trips.

661. **Management of Pupil/Student Personnel Programs** (3) II Services in public schools and/or postsecondary institutions. Area of individual student concentration will depend upon anticipated level of application. P, twelve units of coun. (Identical with Coun. 661)

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 8) 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 1983-84 Field trips.
   c. Public Policy Issues in Higher Education (1) [Rpt.] I II
   d. Community Colleges in the Future (1) [Rpt.] II

696. **Seminar**
   a. Community College Administration (3) I II Field trips.
   d. Governance and Coordination (3) I II Field trips.

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 Open to majors only.

**HINDI**

*(See Oriental Studies)*
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.

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.

DOCTOR'S 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 advisor, 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.

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 Learning 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) I Student personnel services; purposes; procedures; representative programs; current trends. (Identical with Coun. 617)

620. Curriculum in Higher Education (3) I Early classical curriculum; development and administration of general education and professional studies; modern curriculum developments and innovations.

621. Teaching in Higher Education (3) I 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.

630. **Continuing Education** (3) I 1983-84 Development and future trends in continuing education programs in higher education; cultural, social and economic factors affecting continuing education; characteristics of students and programs.

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.

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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 8) I II Biweekly seminar meetings required. P, bachelor's degree plus twelve units, 621 (for students without a subject-field methods course), 615, 560.

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   a. Community College Developments (1 to 3) I 1983-84 Field trips.
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696. **Seminar**
   a. Community College Administration (3) I II Field trips.
   d. Governance and Coordination (3) I II Field trips.

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 Open to majors only.

**HINDI**

*(See Oriental Studies)*
HISTORY


Assistant Professors Karen Anderson, Michael E. Bonine (Oriental Studies), Douglas C. Chen (Oriental Studies), Richard M. Eaton (Oriental Studies), Timothy Lenoir, Kurt Yoshihiro Kuriyama (Oriental Studies), Norman Yoffee (Anthropology)

Lecturer William R. Noyes

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in history. Concentrations are available as indicated at the end of this section. 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 encouraged to submit scores on the aptitude and advanced 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 and advanced 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; China; Japan; India and Pakistan; the Middle East; Women’s History. The student who elects to submit a thesis (six units) is required to complete at least twelve of the remaining 24 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 twelve of the remaining 24 units at the 500 level in history other than independent study. Each student must demonstrate reading knowledge of one foreign language. In special cases, with the consent of the adviser, six additional units of 500-level work or competence in 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.

MASTER OF EDUCATION — All students must complete at least eighteen units in history, no 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 principal area of concentration (see below). If that area is United States or Latin America, the student will select two general fields and one special field within the area. If the area is Eu-
rope or Asia, the student will select one general field and two special fields within the area. In addition, the student will select two supporting fields outside the principal area, one of which may be outside of history. 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 shall be required. Before admission to formal candidacy, each student must pass a comprehensive examination covering the fields chosen in the principal area and one of the two supporting fields. 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.

Principal Areas and Fields

UNITED STATES — General fields: before 1865, after 1865. Special fields: social and intellectual history, ethnic minorities, U.S. foreign affairs, history of the West, history of the South.

LATIN AMERICA — General fields: before 1821, after 1821. Special fields: Argentina and Brazil, Andean Republics, Mexico and the Hispanic Southwest, intellectual history, economic and social history.

EUROPE — General fields: ancient history, medieval history, early modern history, since 1789. Special fields: Greece in the Classical period, the Roman republic, medieval England, Renaissance Italy, Reformation era, European expansion and voyages of discovery, history of science, intellectual history, economic history, diplomatic history, modern France, modern Britain, modern Germany, modern Russia, modern southeastern Europe.

ASIA — General fields: China, Japan, Middle East, India and Pakistan. Special fields: China before 1368, Ming and Ch’in China, 19th- and early 20th-century China, Communist China, Chinese intellectual history, Japan before 1853, Japan after 1853, modern Japanese intellectual history, Islamic history to 1258, Islamic history 1258-1800, modern Middle East since 1800, medieval India, India and Pakistan since 1757, social history of contemporary India and Pakistan.

ART HISTORY — General fields: pre-Columbian, Spanish colonial, American, history of photography.

401. Ancient Mesopotamia (3) GC I 1984-85 (Identical with Anth. 401)

402. History of Biology (2) GC II Great writings in biology and medicine. (Identical with G.Bio. 402) Lenior

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) Weinstein
412a-412b. Intellectual History of Modern Europe (3-3) GC Dominant themes in European intellectual history from the end of the Middle Ages to the Great War, with reading and discussion of texts taken from Petrarch and Ficino to Nietzsche and Freud. 412a is not prerequisite to 412b. 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

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

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

421a-421b. Modern Germany (3-3) GC Political, social, and intellectual history from the end of the Thirty Years War to the end of World War II. 421a is not prerequisite to 421b. Donohoe

422a-422b. Russia before the Bolshevik Revolution (3-3) GC Political, social, economic and cultural developments from the founding of the Russian state to 1917. 422a is not prerequisite to 422b. 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. History of Byzantium (3) GC II Social, political, and cultural history of Byzantium and its impact on Europe and Asia Minor, A.D. 325-1453. (Identical with Clas. 428)

429. 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

430. Discovery and Exploration of the New World (3) GC I Voyages, trade and territorial acquisitions in America from Columbus to Captain Cook. Lamb

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 I II Political, social and economic developments in the United States from the adoption of the Monroe Doctrine through the Mexican War. Gaines

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 Bl.S. 435) Merling

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 Bl.S. 436) Merling

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

440. United States: 1945 to Present (3) GC I II American society and the role of the United States in world affairs from the Yalta Conference to the present. Dinnerstein/Schaller
442a-442b. History of American Society and Thought (3-3) GC Thought, arts, and agencies of cultural life from the 17th century to the present. 442a is not prerequisite to 442b. Carter

446. 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

449a-449b. History of American Foreign Relations (3-3) GC 449a: A study of the American people in an Atlantic community during the 18th and 19th centuries. 449b: An examination of the United States as a world power in the 20th century. 449a is not prerequisite to 449b. Schaller

451. The United States and East Asia: 1840 to the Present (3) GC II 1984-85 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

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

458. 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

459. Historical Archaeology (3) GC II (Identical with Anth. 459)

460. 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)

461. The Iberian Empires (3) GC II The political and economic structure of the Spanish and Portuguese empires in America from Cortes to Bolivar. MacLeod

462. Intellectual History of Latin America since 1810 (3) GC II 1984-85 Latin American thought from Independence to the 20th century; major Latin American thinkers and writers, and influences from Europe and the United States. Brubaker

463. Marxism in East Asia (3) GC I (Identical with Or. S. 463)

464. History of Argentina (3) GC I Survey of Argentine history and culture from the colonial era to the present. Guy

466a-466b. History of Brazil (3-3) GC Brazil’s political, economic, social and intellectual development. 466a: Colonial origins to World War I. 466b: World War I to the present. 466a is not prerequisite to 466b. Guy/Dulles

467. Contemporary Latin America (3) GC II Revolution, social change and reaction in Latin America from 1930 to the present. Guy

468. Asia and the West (3) GC I (Identical with Or. S. 468)

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

472. History of Medieval India (3) GC I (Identical with Or. S. 472)

473. History of Modern India and Pakistan: 1750-Present (3) GC II (Identical with Or. S. 473)

474a-474b-474c. History of Japan (3-3-3) GC (Identical with Or. S. 474a-474b-474c)

475a-475b-475c-475d-475e. Periods in Chinese History (3-3-3-3-3) GC (Identical with Or. S. 475a-475b-475c-475d-475e)

476. Modern Chinese History (3) GC (Identical with Or. S. 476)

477a-477b. History of the Middle East (3-3) GC (Identical with Or. S. 477a-477b)

478. Modern History of the Middle East (3) GC I (Identical with Or. S. 478)

479. The Ottoman Empire to 1800 (3) GC II 1984-85 (Identical with Or. S. 479)

480a-480b. History of Iran and Central Asia (3-3) GC (Identical with Or. S. 480a-480b)

482. Social History of China (3) GC (Identical with Or. S. 482)

489. Women in East Asia (3) GC I (Identical with Or. S. 489)

495. Colloquium
   a. Revolution in Chinese History (3) GC II (Identical with Or. S. 495a, which is home)
   b. Studies in Black America (3) GC II (Identical with Bl. S. 495b)
   c. The Mexican American (3) GC II (Identical with M.A.S. 495c)

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)
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. Colonial Latin America (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

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**HISTORY AND PHILOSOPHY OF SCIENCE**

*Committee on History and Philosophy of Science (Graduate)*

Professors Leon Blitz (Physics), William A. Longacre (Anthropology)
Associate Professors Henry C. Byerly (Philosophy), Chairperson, Robert M. Harnish (Philosophy), Richard E. Michod (Ecology and Evolutionary Biology)
Assistant Professor Timothy Lenoir (History)

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.

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**HOME ECONOMICS**

Professors Robert R. Rice, Director, Victor A. Christopherson, Jean Ruley Kearns, Amy Jean Knorr, Alice B. Lowell (Emerita), Doris E. Manning, Naomi A. Reich, Carl A. Ridley, George Sproles, Mary Adele Wood (Emerita)
Associate Professors Arthur Avery, James R. Hine, Roger M. Kramer, Mary H. Marion, Mary Jean Wylie
Assistant Professors Kitty Abraham, Ellen Goldsberry, William Fasse, Donna Iams, Elizabeth Kendall, Leanne Lamke, Shirley J. O'Brien, Chet Ross, Luan Stewart, Mari Wilhelm, Mary E. Wyant
Lecturer Patricia Otten

The School of Home Economics offers programs leading to the Master of Science degree with majors in home economics, home economics education, and dietetics*. For the Master of Science degree with a major in home economics, concentrations are available in child development and family relations; clothing, textiles and interior design; consumer studies and home management; nutrition and food science; 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 home economics. 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.

* This major is currently under review. For further information, contact the Department of Nutrition and Food Science.

**Divisions**

CHILD DEVELOPMENT AND FAMILY RELATIONS — For the Master of Science degree with a major in home economics, concentrations are available in (1) human development and family studies, 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) preschool program development, which provides training and practicum experience in intervention programs for the young child. Students are required to complete 34 to 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 home economics, 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, home economics, 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 home economics, 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 home economics 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 the Nutrition and Food Science section elsewhere in this catalog.

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**Home Economics**

696. Seminar

z. Home Economics (1 to 3) [Rpt./1] I II
Child Development and Family Relations

Professor Ridley, Chairperson of the Division

407. **Problems in Child Development** (3) GC II 1984-85 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.

427. **Problems in Marriage and the Family** (3) GC II 1983-84 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)

467. **Preschool Teaching Theory** (3) GC I Consideration of individual and group needs, guidance, and program planning in preschools. Field trips. P, 347R, 347L.

487. **Readings in Family Relations** (3) GC II 1984-85 Critical analysis of selected studies and research. P, 137, or 337, or Soc. 321.

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.

527. **Creativity and the Preschool Child** (3) I 1984-85 Consideration of theory and interpretation of research in creative behavior, as related to the young child and the family.

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.

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)

567. **Administration and Supervision of Preschool Programs** (3) I 1983-84 Curriculum planning, administration, supervision, and evaluation of preschool programs in relation to recommended standards and needs of communities.

573. **Family Development** (3) I 1983-84 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 Psych. 100a.

577. **Comparative Family Relations** (2) II 1984-85 Family relations studies in cross-cultural perspective, with emphasis on structure, sex roles: functions, lineage, composition, socialization process, and model personality. P, 337 or Soc. 321.

637. **Trends in Human Relations** (3) II 1984-85 Philosophy, content, and resources for understanding, teaching and working in the field of human relations.
Clothing, Textiles, and Interior Design

Professor Reich, 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. 100a, 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 [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, 344, 145.

484. Textile Analysis (3) GC II 1983-84 Physical and chemical testing, dyes, microscopic analysis and use of textile testing equipment for fabric analysis. 1R, 6L. P, 454.

Interior Design

465. Advanced Housing (3) GC II Analysis of the social and psychological factors affecting family housing. P. Psyc. 100a, Soc. 100, H.Ec. 356.


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

Professor Knorr, 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.

426. Work Analysis and Simplification (3) GC I 1983-84 Work simplification principles and techniques applied to work-area arrangements, use of equipment, storage, and methods of work in the home.

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.

446. The Consumer and the Market (3) GC I II Consumer problems in the American economy under existing market conditions. P, Econ. 100a.

456. Technical Aspects of Housing (3) GC II 1984-85 Procedures and ethics of building; application of research results in preparation of data and requirements; plan analysis; design of areas of the house and storage; materials and finishes. 2R, 3L. P, 356.

466. 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.


438. Philosophy and Principles of Extension Education (2) GC II (Identical with A.Ed. 438)

439. Extension Education Methods (2) GC I (Identical with A.Ed. 439)

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 H.Ed. 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)
   s. Senior Workshop in Extension (2) GC II (Identical with A.Ed. 497s, which is home)

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)
   h.* Family Development through Home Economic Programs (1 to 2)
   i. Principles of Extension Training (1 to 3) I (Identical with A.Ed. 597i, 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.

628. Curriculum Theory in Home Economics (3) I Theoretical bases and processes of curriculum building in home economics; current issues in home economics education.

HYDROLOGY AND WATER RESOURCES

Professors Nathan Buras, Head, 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, Sol D. Resnick (Water Resources Research Center), Eugene S. Simpson

Associate Professors Michael D. Bradley, Donald R. Davis, Soroosh Sorooshian, Charles W. Stockton (Laboratory of Tree-Ring Research)

Assistant Professors Judith M. Dworkin, Glenn M. Thompson

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**

405. **Hydrology of Unsaturated Media** (3) GC I Physical properties and processes of unsaturated media related to storage and movement of water and transport of contaminants. P, Phys. 103b, Math. 125b. (Identical with S.W.E. 405)

414. **Field Hydrology (Summer Camp)** (6) GC S Field methods of collection, compilation and interpretation of hydrologic data; geologic and geophysical methods; preparation of hydrologic reports. Lab. comprises daily field work. Fee.

423. **Hydrology** (3) GC I (Identical with C.E. 423)

435. **Hydrogeology** (3) GC I II Geologic and hydrologic factors controlling occurrence and development of ground water. 2R, 3L. Field trips. P, Geos. 101a or 151. (Identical with Geos. 435)


460. **Watershed Hydrology** (3) GC I (Identical with Ws.M. 460)

471. **Water Quality Control** (3) GC II (Identical with C.E. 471)

480. **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.

481. **Physical Oceanology and Limnology for Hydrologists** (2) GC II 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) 1 1984-85 (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.
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.

Water Quality Dynamics (3) II Physical and chemical methods are used to study and predict dispersion of pollutants and water quality changes in ground and surface water, with emphasis on interpretation of water quality and the use of environmental tracers to understand the evolution of ground-water chemistry. P. 435.


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)

Advanced Surface Water Hydrology (3-3) Fluvial dynamics and flood routing; flood hydrology; hydrology of water supply; classical and numerical methods. P, 423.

Advanced Statistical Hydrology (3) I 1984-85 Advanced application of statistics and probability to hydrology and water resources; multivariate modeling, choice of models and parameters, simulation, Bayesian decision theory. P, 445.

Isotope Hydrology (3) (Identical with Geos. 564)

Hydrochemistry (3) II 1983-84 (Identical with S.W.E. 565)

Seminar
p. Hydrogeology (1 to 3) [Rpt./2] I II (Identical with Geos. 596p)

Well Hydraulics and Pumping Test Analysis (2) II 1984-85 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.

Soil Water Dynamics (3) II 1984-85 (Identical with S.W.E. 605)


Stochastic Methods in Hydrology (3) II 1983-84 Event-based and time series analysis of hydrologic phenomena; use of stochastic process models of streamflow, river networks, aquifers, evaporation, reservoirs, precipitation.

Colloquium
a. Hydrology (1 to 3) [Rpt./1] I II

Seminar
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 1984-85

e. Pollutants in the Hydrologic Environment (1 to 3) I II

Water Resources Administration

Water Resource Management (3-3) GC The ecological relation of water in the biosphere with special reference to the human role; the role of behavioral sciences (social, legal, economic, political, and psychological) in the development, conservation, regulation, and utilization of water resources; analysis of case-study materials to develop principles of resource management. 401a is not prerequisite to 401b. (Identical with Geog. 401a-401b)

Population and Resources (3) GC I (Identical with Geog. 461)

Natural Resource Economics (3) GC II (Identical with A.Ec. 476)

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

Environmental Policy (3) GC II (Identical with Pol. 481)

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.

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 1984-85 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. 272. (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] I 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
   k. Coupled Physical-Social Resource Models (1 to 3) II

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.

The following are administered by the Office of Interdisciplinary Programs: applied mathematics, biomedical engineering, history and philosophy of science, and statistics. Others, such as gerontology, are in various stages of development.

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 U.Pl. 596u)

INTERIOR DESIGN
(See Home Economics)

ITALIAN
(See French and Italian)

JAPANESE
(See Oriental Studies)
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 the department's two basic writing courses, 205 and 206, 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 a departmental newspaper and to demonstrate a high level of skill in reporting and writing courses. The program of study must also include 411, 413, 420, 470, 502, 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.

401. Photojournalism (2) GC I II Reporting and interpreting the news through pictures.
402. Photojournalism Laboratory (1) GC I II Open to majors only. P, CR 401.
403. Advanced Photojournalism (3) GC I II Open to majors only. P, 401, 402.
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.
420. Editing (2) GC I II Theory and techniques of copy editing and headline writing; training on video display terminals. 1R, 3L. P, 208, 206 or CR. Department permission required.
423. Modern Production Methods (1 to 2) GC [Rpt./1] I II Comparative study of print production methods, with lab. application. P, 206.
450. Community Journalism: The Tombstone Epitaph (3) GC [Rpt.] I II Class members work as editorial staff to produce the local newspaper for Tombstone, Arizona. Intensive study of problems and responsibilities of community newspapers. P, 206, 208, 401, 420, discussion of preparation with instructor.
451. **Community Journalism: El independiente** (3) GC [Rpt.] I 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, 401, 420, 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.

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.

473. **Readings in Mass Communications** (3) GC [Rpt.] I II Individual course of readings approved by instructor to cover subject specialty not available in other course offerings.

497. **Workshop**
   a. Color Photography (2) GC [Rpt. / 1] 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.

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

**LANDSCAPE ARCHITECTURE**
*(See Renewable Natural Resources)*

**LATIN AMERICAN STUDIES**

*Latin American Area Center*

Committee on Latin American Studies

Director: Michael C. Meyer
Assistant Director: Susan M. Deeds

Committee on Latin American Studies

Professors Michael C. Meyer (History), Director, Donald W. Carson (Journalism), Lanin A. Gyurko (Spanish and Portuguese), Boris S. Kozolchyk (Law), Murdo J. MacLeod (History), 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 with counseling, internships, and job interviews.

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 eighteen (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; geography and re-
gional development; political science; history; home economics; 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 exami-
nation. 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.

456. **Southwest Studies I** (3) GC (Identical with Sw.C. 456)
457. **Southwest Studies II** (3) GC (Identical with Sw.C. 457)
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**

Professors Roger C. Henderson, Dean, Arthur W. Andrews, Charles E. Ares, William E. Boyd,
Claude H. Brown (Emeritus), Ronald L. Cherry, Robert Emmet Clark (Emeritus), Dan
B. Dobbs, Mary Doyle, August G. Eckhardt, Thomas L. Hall (Emeritus), Kenney F.
Hegland, Reka P. Hoff, Junius Hoffman, John J. Irwin, Jr., William E. Kimble
(Adjunct), Boris Kozolchyk, Robert O. Lesher (Adjunct), Joseph M. Livermore, Jack
J. Rappeport, G. Kenneth Reibich (Emeritus), Thomas L. Schuessler, Charles
Marshall Smith, Roy G. Spece, Jr., Thomas J. Tormey (Emeritus), Willard N. Van
Slyck, Jr. (Emeritus), David B. Wexler, Norman Williams, Winton D. Woods, Jr.

Associate Dean Armando Rivera
Associate Professors Mark L. Ascher, Elizabeth Buchanan, Thomas A. Mauet, Thornton E.
Robison

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 de-
gree 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)
615. Private Corporations (3)
616. Corporate Finance (2) P, 616.
617. Antitrust Law (3)
618. Immigration Law (2)
619. Administrative Law (3)
620. Law Review (1 to 3)
621. Conflict of Laws (3)
622. Labor Law (3)
623. Jurisprudence (3)
624. Comparative Law (3)
625. Legal Process (3)
626. Indian Law (2)
627. Commercial Process (4) I II
628. Products Liability (2) II
629. Insurance (2)
630. Federal Tax Procedure (2) II P, 646.
632. Real Estate Transactions (3)
633. Community Property (2)
634. Mining and Public Land Law (3)
635. Water Law (3)
636. Federal Jurisdiction (3)
637. Arizona Civil Procedure (3)
644a-644b. Remedies (1-3)
645. Trial Practice (2) I II P, 608, 609.
646. Federal Income Taxation (4)
647. Corporate Taxation (3) II P, 646.
648. Estate and Gift Taxation and Basic Estate Planning (3) I P, 610, 611.
649. Torts (3)
650. Criminal Law (3)
651. Accounting and the Law (2)
652. Income Taxation of Estates and Trusts (2) II P, 611, 646.
653. Advanced Appellate Practice and Moot Court (2)
654. The First Amendment (3)
655. Civil War Amendments (3)
656. Law of the Elderly (2)
658. Securities Regulation (3)
659. Growth Management (3) II 1984-85 (Identical with U.Pt. 659, which is home)
660. Land-Use Planning (3)
661. Moot Court Board (2)
662. Creditors' Remedies (2)
663. Bankruptcy (2)
665a-665b. Interviewing, Counseling and Negotiation (1-1) 665a is not prerequisite to 665b.
666. Preservation of Historic Environments (3) II 1983-84 (Identical with U.Pt. 669, which is home)
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 (2 to 3) II
j. Child, Family and State (3) I
m. Landlord and Tenant (2) I
o. Law and Psychiatry (3) I
p. Law and Technology (3) I II
bb. Advanced Civil Procedure (3) I
c. Clinical Practice (2) II P, 608, 609, 645.

LIBRARY SCIENCE

Professors Ellen Altman, Director; Donald C. Dickinson, Robert K. Johnson, Margaret F. Maxwell, Allan D. Pratt, Arnulfo D. Trejo, Lawrence Clark Powell (Emeritus), Elinor C. Saltus (Emerita)

Associate Professors Robert A. Berk, 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 and the Master of Education degree with a major in school library science. Concentrations for the Master of Education degree are available in elementary education or in secondary education. The Master of Library Science degree qualifies graduates for professional positions in all fields of librarianship including academic, public, and special libraries. To be qualified for school libraries, specified courses in education are necessary for certification. The Master of Education degree with a major in school library science qualifies graduates for school library positions only. 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.

MASTER OF EDUCATION — Applicants must have completed the bachelor’s degree, including at least fifteen units in education (of which six are in library science) with a grade point average of at least 3.00. A personal interview may be required, to be held in Tucson, or by arrangement with the Graduate Library School, at other locations. All applicants must submit scores not more than five years old on the Miller Analogies Test or the aptitude test of the Graduate Record Examination, personal resumes and statements of purpose, and two letters of recommendation to the Graduate Library School. Applications and all supporting materials must be received by June 1 for applicants planning to enroll for the fall semester, by December 1 for those planning to enroll for the spring semester, and by May 1 for those planning to enroll for the summer session.
All students must complete at least 32 units including twenty units in school library science. Students with undergraduate minors in school library science may elect, with the consent of an adviser, to take additional work in education in lieu of a part of the twenty-unit requirement in school library science. The degree program and prerequisites must include 417, 480, 485, 502, 505, 581, 582, 693, either 503 (secondary education majors only) or 486 (elementary education majors only), Ed.F.A. 603, and appropriate electives. All students must pass a comprehensive final examination. For further information see Requirements for Master's Degrees/Master of Education 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 — L.I.S. 460, 502, 503, 505, 581, 582, and 693d; secondary school — L.I.S. 485, 502, 503, 505, 581, 582, and 693d.

417. Visual and Auditory Aids in Teaching (3) GC I II (Identical with S.Ed. 417)
441. Children's Literature in Spanish (3) GC I (Identical with Span. 441)
443. Mexican-American Literature (3) GC I (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)
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.
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. P. 510.
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. P. 510.
513. Library Systems Analysis (3) I Introduction to quantitative methods for the design, analysis and control of library systems. P. 510.
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. P. 502.
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. P. 502, 505.
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. P, 505.

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. P, 507.

531. Outreach: Library Service for Special Groups (3) I Survey of library services and resources for the aged, handicapped, non-English speaking, disadvantaged, adult learners, A.B.E. students, and institutionalized patrons. (Identical with M.A.S. 531)

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. P, 480.

540. Academic Librarianship (3) I Present trends in academic libraries, including financial administration, collection evaluation, personnel requirements and building needs. P, 507.

550. Special Librarianship (3) I I Mission, organization and administration of the special library. P, 507 or equivalent experience.

551. Management of Health Sciences Libraries (3) Management functions applied within the context of the biomedical communication network; includes NLM classifications, design of buildings, audiovisual usage, and recent innovations. P, 502, 505, 507 or equivalent experience.

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) I 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 Rdnng. 561)


563. Communication in Libraries: Public Service (1) I I Problems of face-to-face communication at public service desks.

564. Communication in Libraries: Organization (1) I I Group dynamics and organizational communication as related to libraries.

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. P, 505.

571. Information Sources in the Social Sciences and Humanities (3) I I 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. P, 505.

573. Government Publications (3) I 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.

580. Current Trends in Children's Literature (3) I I Topical approach to juvenile publishing, requiring analysis and reaction. Among trends examined are controversial subject matter, racism and sexism, internationalism, books in audiovisual formats. P, 480.


582. Audiovisual Materials in Libraries (2) I I Introduction to AV information resources for the library.

600. Introduction to Graduate Study in Music (3) (Identical with Mus. 600)

616. Coordination of Instructional Media Programs (3) I I (Identical with S.Ed. 616)

617. Preparation of Instructional Materials (3) I I (Identical with S.Ed. 617)

693. Internship
   c. Public Library (2 to 4) I I S. P, 502, 503, 505, 507, CR 530.
   d. School Library (2 to 4) [Rpt. I.I] I I P, 480 (elementary only) or 485 (secondary only), 502, 503, 505, CR 581.
   e. Community College Library (2 to 4) [Rpt. I.I] I I S P, 503, 504, 507.

695. Colloquium
   e. Theory of Classification (1 to 3) I I
   g. Laboratory in Library Communications (1 to 3) I I
LINGUISTICS

Professors Adrian Akmajan, Head, Richard Demers, Robert Michael Harnish (Philosophy), Adrienne Lehrer
Associate Professors Susan Steele, Richard T. Oehrle

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, 412, 413, 501, 544, and two of 422, 475, and 477.

MASTER OF ARTS — In addition to the courses listed above, students are expected to take the following: 540, either 502 or an advanced phonology course, and one year of coursework 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 coursework. 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)

412. 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.

413. Linguistic Phonetics (3) GC Articulation and acoustics of the wide range of sounds used in human languages, with extensive practice in discrimination, transcription, and production.

417a-417b. Sanskrit Grammar and Texts (3-3) GC 1984-85 (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 1984-85 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.


450. Language and Social Issues (3) GC II S 1983-84 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.
Acquisition of Speech and Language (3) GC II (Identical with Sp.H. 451)

Linguistics and the Study of Literature (3) GC II 1984-85 Linguistic methods in the analysis of literature and implications of literary language for linguistic theory; detailed consideration of prosody, metaphor, narrative technique and irony. (Identical with Engl. 461)

Speech Production and Comprehension (3) GC II 1984-85 (Identical with Phil. 473)

Semantics (3) GC II 1983-84 (Identical with Phil. 475)

Language in Culture (3) GC II (Identical with Anth. 476)

Pragmatics (3) GC I 1983-84 Study of language use, its relationship to language structure and context; topics such as speech acts, presupposition, implication, performatives, conversations. (Identical with Phil. 477)

Historical Comparative Linguistics (3) GC I (Identical with Anth. 480)

Colloquium

a. Linguistics (1) [Rpt./3] GC I

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.

Intermediate Syntax (3) II Examination of the modifications of "standard" transformational theory; constraints on transformations, abstract syntax and generative semantics, extended standard theory. P, 400.

Advanced Syntax (3) I Analysis of various grammatical constructions; treatments of the distinction between local and nonlocal dependencies. P, 501.

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.

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.

Sociolinguistics (3) I (Identical with Anth. 583)

Seminar

u. Case and Pananian Grammar (3) [Rpt.] II 1983-84 (Identical with Or.S. 596u, which is home)

Current Issues in Linguistic Research (3) [Rpt./1] Current research in linguistics, with emphasis on relationships among syntax, semantics, and phonology.

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) I II (Identical with Sp.C. 696f, which is home)

MANAGEMENT


Associate Professors Nicholas J. Aquilano, John W. Dickson, Marvin Fortman, Hollis K. Martin, David A. Tansik, Robert E. Tindall

Assistant Professors J. Richard Harrison, Margaret A. Neale, Gregory B. Northcraft, Gustavo A. Vargas

Lecturers Paul Baker, Louie B. Chester, Herbert Muller, William W. Wiessler

The Department of Management is being reorganized. For information contact the department head.

The department offers a program leading to the Master of Science degree with a major in management. 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 Require-
ments for Master's Degrees/Master of Business Administration and Master of Public Administration and the headnotes under Business Administration and Public Policy, Planning and 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 sixtieth percentile or better on the Graduate Management Admissions Test is required for admission consideration.

The program for the Master of Science degree with a major in management 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.

420. **Advanced Business Law** (3) GC I II Negotiable instruments, partnerships, corporations, and property rights. P, CR 320 or admission to BPA graduate programs.

426. **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.

430. **Personnel Policies** (3) GC II 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.

435. **Sociotechnical Systems** (3) GC I Theory and practice of installing high-commitment work systems to increase productivity and improve the quality of working life.


473a-473b. **Production and Operations Management** (3-3) 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.

474. **Work Simplification** (3) GC I II Work simplification and motion economy; methods of increasing productivity of employees; flow process charts and flow diagrams; appraisal of fatigue in business and industry. P, 305.

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.

500. **Business Case Analysis and Presentation** (3) 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.

502. **Organization Theory and Behavioral Relations** (3) I II The interactions, effects, and interrelationships of managers, employees, and organizational structures and systems. Open only to students admitted to a BPA graduate program.

521. **Legal Environment of International Business** (3) I Legal institutions and processes affecting international business.

552. **Statistical Decision Making** (3) I II Probability and statistical analysis; random variables, sampling distributions, hypothesis testing, Bayesian analysis, time series, statistical investigation. Open only to students admitted to a BPA graduate program. P, M.I.S. 500, or Math. 119 and 123.

554. **Research Methodology** (3) I Behavioral research techniques; bias, validity, reliability, and applicable statistical techniques; critiques of research articles and reports. P, 552.

571. **Business 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.

572. **Operations Management** (3) I Intended for students without a background in production management. Survey of techniques useful in operating both manufacturing and service industries.

573. **Business and Society** (3) I II Relationships between business organizations and economic, social and political processes; business responsibilities to various interest groups. P, 305 or 502.

577. **Business Policy and Performance Simulation** (3) I II Management experience vicariously achieved by students serving as executives of competing companies; decisions are computer processed.
580a-580b. Theory of Management and Organization (3-3) 580a: Analysis of behavior in organizational systems; review of classical, behavioral, and contingency theories of management with a focus on internal systems phenomena. 580b: Organizations in their environments; analysis of organizations in the context of their environmental interfaces. P, 305 or 502. 580a is a prerequisite to 580b.

582a-582b. Multivariate Analysis in Business (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.

585. Material Requirements Planning and Control (3) II Material management with emphasis on forecasting and inventory theory within a dependent demand environment.

600. Behavioral Science Theory and Method in Management (3) [Rpt. 1] I 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.

603. Human Resource Management (3) I Principles, methods, research relevant to management of an organization's human resources, with emphasis on employment psychology, training, development, compensation. P, 305 or 502.

604. Organization Development and Change (3) II Concepts and skills relevant to persons concerned with problem diagnosis and organizational development and change. P, 305 or 502.

696. Seminar
a. Ethics in American Business (2 to 4) I II
b. International Business Management (2 to 4) I II
c. Research Design: Statistical Methods (2 to 4) I II

MANAGEMENT INFORMATION SYSTEMS

Professors Jay F. Nunamaker, Jr., Head, Seymour Goodman, James F. LaSalle, Roy E. Martin, Richard O. Mason
Associate Professors Benn Konsynski III, Averill Law, Mary E. Loomis, Timothy L. Shaftel
Assistant Professors Phillip D. Beck, Gary S. Klein
Lecturer Wayne M. Eirich

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 and Public Policy, Planning and Administration departmental 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 sixtieth percentile or above on the Graduate Management Admissions Test. Applicants must also have completed preparatory work in finite mathematics, calculus, statistics, economics, business law, 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 Acct. 550, 551; Mgmt. 502; Mktg. 500; and Fin. 511. 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. A typical plan of M.I.S. courses would consist of 521a, 531a, 531b, 541a, 541b, 551a, 551b, 511, 696c, and master report. Courses may be waived as a result of prior preparation. Minimum requirements after waivers must include at least 15 units in M.I.S. including 511, and at least 16 units in the 500 and 600 series. A master research report (3 units) or a master thesis (6 units) is required.
421. **Simulation Modeling and Analysis** (3) GC Modeling and analysis of probabilistic real-world systems by means of simulation; building simulation models in FORTRAN and in a simulation language such as SLAM or GPSS; introduction to the analysis of simulation output data. P; Mgmt. 275, M.I.S. 301. (Identical with C.Sc. 421)

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)

451. **Advanced Business Programming Techniques** (3) GC I Large scale business systems, advanced file organization concepts and programming, advanced COBOL features, software testing and debugging support tools, programming language generics. P, 301.

461. **Accounting Information Systems** (3) GC I I I (Identical with Acct. 461)

501. **Management Information Systems** (3) I I I 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 crimes; 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, Mgmt. 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 databases. 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, Mgmt. 552.

575. **Stochastic Models in Management Science** (3) I II Application of math. to decision-making; computers in optimization and resource allocations in management environment; inventory theory, dynamic programming. P, Math. 123.

577. **Nonlinear Mathematical Programming** (3) I I I 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.

579. **Mathematical Programming Software Design and Construction** (3) I Fundamentals of modeling systems, with emphasis on the business applications of mathematical programming solutions; techniques for the design and construction of mathematical programming software. P, 421a.

596. **Seminar**
   a. Computers in Auditing (3) I II P, 341 or Acct. 461. (Identical with Acct. 596a)
MARKETING

Professors Joseph W. Newman, Head, Gary M. Munsinger, Lyman E. Ostlund
Associate Professors James M. McCullough, Richard A. Scott, Robert A. Westbrook
Assistant Professors William C. Black, Jerry N. Conover, Karen L. LeMasters, Michael D. Reilly,
Sushila Umashankar, Melanie R. Wallendorf
Lecturers Charles A. Boyd, Jeffrey A. Nordensson

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 sixtieth 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.

410. Small Business Marketing and Management (3) GC I II Planning, organizing, and establishing a small business; evaluation of existing businesses and franchise operations; market feasibility studies; preparation of a business development plan. P. 361.

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. 361.


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.

455. Management of Distribution Systems (3) GC I Nature and operation of channels in the distribution of goods and services; economic and behavioral problems in wholesaling and retailing; marketing logistics. 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.

459. Product Management (3) GC II Product (services) strategy for achieving financial growth; evaluating opportunities; generating ideas; launching new offerings; managing the product (services) portfolio. P. 361.

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) I 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) II 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.

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, Mgmt. 552.

601. **Behavioral Science Applications in Management** (3) II Applications of behavioral science theories, concepts and methods in the study of problems in management. P, Mgmt. 600.

696. **Seminar**
   a. Marketing Research Methodology (3) I II P, 500, Mgmt. 552.

**MATERIALS ENGINEERING**

Committee on Materials Engineering (Graduate)

Professors Robert H. Chambers (Physics), Bernhard O. Seraphin (Optical Sciences), Morton E. Wacks (Nuclear and Energy Engineering), Donald H. White (Chemical Engineering), Frank Wiersma (Soils, Water and Engineering)

Associate Professors Reginald L. Call (Electrical and Computer Engineering), Paul H. Wirshing (Aerospace and Mechanical Engineering)

Assistant Professor Krishna Seshan (Metallurgical Engineering)

The Committee on Materials Engineering administers programs of study for an interdisciplinary doctoral minor in materials engineering.

For further information, contact the dean's office, College of Mines, or the head of the Department of Metallurgical Engineering.

**MATHEMATICS**

*(See also Applied Mathematics)*


Assistant Professors Christopher Jones, John N. Palmer, Peter Tannenbaum, Robert Valentini Lecturers Robert C. Dillon, John L. Leonard, Stephen G. Tellman
The department offers programs leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees with a major in mathematics. Concentrations are available in pure, applied, or computer mathematics or in probability and statistics. As there are no sharp boundaries between these concentrations, students are encouraged to pursue a broad range of mathematical topics. Programs are planned in consultation with the departmental faculty. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a 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 and modern algebra. 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. The program must include 525a-525b and 24 additional units in mathematics with an emphasis on courses at the 500 level. 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 and satisfy the language requirement. 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. The language requirement 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 I 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 and Phl. 402)

403. Foundations of Mathematics (3) GC II 1984-85 Topics in set theory such as functions, relations, direct products, transfinte 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)

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. P. 125b.
405. **Mathematics in the Secondary School** (3) GC II Not applicable to the math. major in the College of Liberal Arts. (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.

413.* **Linear Algebra** (3) GC II Vector spaces, linear transformations and matrices, eigenvalues, bilinear forms, orthogonal and unitary transformations. P. 215.

415a-415b. **Introduction to Modern Algebra** (3-3) GC Introductory topics in abstract algebra, groups, rings, vector spaces, linear algebra, modules, field extensions. P. 215 for undergraduates.

420. **Calculus of Variations** (3) GC I 1983-84 Euler equations and basic necessary conditions for extrema, sufficiency conditions, introduction to optimal control, direct methods. P. 225, and 253 or 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 253 or 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. Credit allowed for 422a or 322, but not for both. P. 223 or 225, and 253 or 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, and Riemann integration 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.**


426. **Advanced Calculus of Several Variables** (3) GC II Differentiation of functions of several variables, implicit function theorem, multiple integrals, differential forms, line and surface integrals. P. 425.

430. **Second Course in Geometry** (3) GC II Topics to be selected from projective geometry, hyperbolic geometry, such areas as metric geometry, and combinatorial topology. P. 215.

434. **Introduction to Topology** (3) GC II 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 253 or 254 or 255.

435. **Theory of Graphs and Networks** (3) GC II 1983-84 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. **Combinatorial Mathematics** (3) GC II 1984-85 Enumeration and construction of arrangements or designs, theorems on existence and nonexistence of designs, applications to design of experiments and error correcting codes. P. 415a.


455.* **Elementary Partial Differential Equations** (3) GC I Theory of characteristics for first order partial differential equations; second order elliptic, parabolic, and hyperbolic equations. P. 225, and 253 or 254 or 255.


*Credit allowed for only one from each of the following groups: 455 or 456; 410 or 413.

461. **Elements of Statistics** (3) GC 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)


468. **Applied Stochastic Processes** (3) GC II Applications of Gaussian and Markov processes and renewal theory; Wiener and Poisson processes, queues. P, 464. (Identical with Stat. 468)\(^1\)

473. **Theory of Computation** (3) GC I II (identical with C.Sc. 473)

475a-475b. **Mathematical Principles of Numerical Analysis** (3-3) GC Introduction to theoretical numerical analysis with applications to errors, interpolation, approximations, numerical integration and differentiation, roots of polynomial equations, numerical quadrature, solution of ordinary differential equations. P, 223 or 225, and 253 or 254 or 255, and 275 or knowledge of scientific computer programming. (Identical with C.Sc. 475a-475b)

478. **Computational Methods of Linear Algebra** (3) GC II Numerical methods involved in the solution of linear systems; matrix inversion, eigenvalue problems, ill-conditioned matrices. P, 410 or 413 or 415b, and 275 or C.Sc. 122 or knowledge of scientific computer programming. (Identical with C.Sc. 478)

479. **Game Theory and Mathematical Programming** (3) GC II 1983-84 Linear inequalities, games of strategy, minimax theorem, optimal strategies, duality theorems, simplex method. P, 410 or 413 or 415b. (Identical with C.Sc. 479)

484. **Operational Mathematics** (3) GC II Basic concepts of systems analysis, Fourier and Laplace transforms, difference equations, stability criteria. P, 421 and 424, or 422b.

515a-515b. **Modern Algebra** (3-3) Structure of groups, rings, modules, algebras; Galois theory. P, 415a-415b.

516a-516b. **Algebraic Number Theory** (3-3) 1983-84 Dedekind domains, complete fields, class groups and class numbers, Dirichlet unit theorem, algebraic function fields. P, 515b.

517a-517b. **Group Theory** (3-3) 1984-85 Selections from such topics as finite groups, noncommutative groups, abelian groups, characters and representations. P, 515b.

518. **Topics in Algebra** (3) [Rpt.] I II Advanced topics in groups, rings, fields, algebras; content varies.

519. **Topics in Number Theory and Combinatorics** (3) [Rpt.] I II Advanced topics in algebraic number theory, analytic number theory, class fields, combinatorics; content varies.


525a-525b. **Real and Complex Analysis** (3-3) Functions of bounded variation; Riemann—Stieltjes, Lebesgue and Lebesgue—Stieltjes integral; real and complex Lp spaces; differentiation of real and complex functions; basic theory of analytic functions. P, 425.


529. **Topics in Modern Analysis** (3) [Rpt.] I 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) 1984-85 Point set topology, homotopy, homology. Applications, such as manifolds, duality, fixed point theorems, solutions to differential equations. P, 415a and 434.

536a-536b. **Calculus of Tensors and Exterior Differential Forms** (3-3) 1984-85 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) I II 1983-84 Construction and properties of error correcting codes; encoding and decoding procedures and information rate for various codes. P, 415a. (Identical with E.C.E. 539)

555a-555b. **Partial Differential Equations** (3-3) 1983-84 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) 1983-84 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) 1983-84 A decision theoretic approach to estimation and hypothesis testing, sequential methods; large sample methods. P, 423, and 464 or 564a.


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 C.R 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 1984-85 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 1984-85 (Identical with E.C.E. 636)

MECHANICAL ENGINEERING
(See Aerospace and Mechanical Engineering)

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 Psyl. 495b)
Seminar

b. Epidemiologic Methods (1 to 3)
d. Host Defense to Disease (2)
e. Occupational and Environmental Health (1 to 3)
g. Professionalization of Issues Concerning Illness and Death (2)
j. Cardiovascular Pharmacology (2)
m. Principles of Medical Education (2) I II
s. Fluid and Electrolyte Balance and Renal Immunology (2)
t. Pathophysiology of Respiratory Diseases (2)
u. Current Issues in Health Services (2)
b. Geriatrics-Gerontology (1 to 3) II
c. Community and International Nutrition (1 to 3) II (Identical with N.F.S. 596cc)
d. Maternal/Child Health (1 to 3)
e. Clinical Epidemiology (2)
g. Medical Jurisprudence (2)
h. Pathogenesis of Rheumatic Diseases (2)
s. Tropical Disease Problems (2)
y. Basic Principles of Epidemiology (2) [Rpt./1]
z. Pathogenesis and Approach to Immunological Diseases (2)

Anatomy
(See "Anatomy" elsewhere in this catalog)

Anesthesiology

Professors Burnell R. Brown, Jr., Head, Casey D. Blitt, Robert W. Vaughan
Associate Professors I. Glenn Sipes, Charles W. Otto
Assistant Professors John B. Bentley, Jerry M. Calkins, Randall C. Cork
Lecturers Reynolds J. Saunders, Kathleen M. Schrader, Harry B. Walker

Biochemistry
(See "Biochemistry" elsewhere in this catalog)

Family and Community Medicine

Professors Anthony F. Vuturo, Head, Herbert K. Abrams, George D. Comerci, Melvin H.
Goodwin, Andrew W. Nichols, James R. Shaw, William A. Stini, Hugh C. Thompson
Associate Professors Peter J. Attarian, Robert W. Buckingham, Gail G. Harrison, Theodore H.
Koff, Daniel O. Levinson, Douglas H. Lindsey
Assistant Professors Dorian H. Cordes, Ronald S. Fischler, Jonathan C. Hake, Craig L.
McClure, Michael K. Magill, Lawrence M. Moher, Ronald E. Pust, William L. Roberts,
Arthur B. Sanders, Jean E. Sullivan, Barry D. Weiss
Lecturers Esther E. Alcorn, Leon Bennet-Alder, W. Andrew Curtain, Lianna M. Edwards, Jil
Feldhausen, Lois W. Kamel, Betty F. King, Bertha Leis, Dalton McClelland, Augusto
Ortiz, Kathleen M. Rest, Robert C. Rhode, Bernhardt E. Stein, Diane G. Hillman

500. Research (2 to 16) [Rpt./2], P, basic science courses.

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

696. Seminar
a. Research Topics and Methodologies in Family and Community Medicine (1) [Rpt./1] I II Consult
department before enrolling.
Internal Medicine


Lecturers Robert L. Brooks, Benjamin Burbank, James Corrigan (Pediatrics), William Faris, Mary L. Fines, David Flieger, Gerald Goldstein, Robert Heusinkveld (Radiology), Margaret Miller, Susan Newman (Social Services), Milan Novak, Donald Ridenour, Gail E. Riggs, Alan R. Rosenfeld, Hans F. Stein

500. Research (2 to 16) [Rpt./1]

555. Cancer Biology (3) II (Identical with M.Mic. 555)

Molecular and Medical Microbiology

(See “Molecular and Medical Microbiology” elsewhere in this catalog)

Neurology

Professors Peggy Ferry (Pediatrics), William A. Sibley
Associate Professors Colin R. Bamford, Acting Head, Jose F. Laguna, Stuart R. Snider
Assistant Professors Enrique L. Labadie, Barrett Katz
Lecturers Robert H. Hamilton, Juan C. Lerman

495. Colloquium
b. Introduction to Neurosciences II (2) GC (Identical with Med. 495b, which is home)

500. Research (2 to 16) [Rpt./1]

Obstetrics — Gynecology

Professors C. D. Christian, Head, Jack Pearson, Lewis Shenker
Associate Professors Diane S. Fordney, William C. Scott, Earl Surwit, Louis Weinstein
Assistant Professors Herbert E. Pollock, Kathryn Reed, Sheldon Weiner
Ophthalmology

Associate Professor Jonathan Herschler, Head
Assistant Professor Barrett Katz

Pathology

Associate Professors James M. Byers, III, Peter C. Johnson, Douglas H. McKelvie, Richard E. Sobonya, Philip D. Stansifer, David C. White
Assistant Professors Anna R. Graham, Thomas M. Grogan, Mary Jane Hicks, Ronald Schifman, Karen K. Steinbronn
Lecturers Louis Hirsch, Paula F. Lowe, Claire M. Payne

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.

Pediatrics

Associate Professors Sergio A. Bustamante, Burris Duncan, Marilyn J. Heins, John J. Hutter, Jr., Richard J. Lemen, Michael J. Schumacher, Elsa Sell, Lynn M. Taussig, Alayne Yates

Pharmacology

(See “Pharmacology” elsewhere in this catalog)

Physiology

(See “Physiology” elsewhere in this catalog)

Psychiatry

Professors Alan I. Levenson, Head, Allan Beigel, Larry E. Beutler, Henry W. Brosin, John C. Racy, Stephen C. Scheiber
Associate Professors Diane S. Fordney (Obstetrics and Gynecology), Alfred Kaszniak, Stephen B. Shanfield, Henry I. Yamamura (Pharmacology), Alayne Yates
Assistant Professors Peter J. Attarian (Family and Community Medicine), Shirley N. Fahey, Milton Frank, John S. LaWall, Russell D. Martin, John J. Miasiaszek, Catherine Shisslak

495. Colloquium
b. Introduction to Neurosciences II (2) GC (Identical with Med. 495b, which is home)

Radiology


Associate Professors Silvio A. Aristizabal, George T. Bowden, Tom Cetas, William G. Connor, Eugene W. Gerner, Kai Haber, Robert Henry, Bruce Hillman, Tim Hunter, Bruce Magun (Anatomy), Gerald Pond, Bryan Westerman, James M. Woollen

Assistant Professors John C. Bjelland, Raymond Carmody, Michael Moore, James Oleson, Del Steinbronn

Lecturers Randy Brogden, Richard Claypool, Jack N. Hall, Douglas McKeivie (Animal Resources), Hugh Murrell

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.

555. Cancer Biology (3) II (Identical with M.Mic. 555)

596. Seminar
h. Control of Proliferation in Animal Cells (1 to 2) I P, permission of instructor. (Identical with M.Mic. 596h)

Surgery


Assistant Professors Robert B. Dzioba, Kenneth V. Iserson, Keith R. Kaback, Marc Kobernick, James M. Malone, Kenneth E. McIntyre, Roger W. Miller, Arthur B. Sanders, H. Thomas Sethney, Del V. Steinbronn
MEDIEVAL STUDIES

Committee on Medieval Studies (Graduate)

Professors Sigmund Eisner (English), Chairperson, Dana A. Nelson (Spanish and Portuguese)
Associate Professors Alan E. Bernstein (History), Richard C. Jensen (Classics)
Assistant Professors Pack Carnes (German), Donald K. Garfield (Art)

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, 590c; Class. 401; Engl. 426, 427, 527a-527b, 590a; Ger. 400a, 511a-511b, 520a-520b, 696a; Hist. 405a-405b, 406, 407, 408; Mus. 500q, 530, 696a; Phil. 261; Franc. 402, 422, 520a-520b, 696a, 696c; Ital. 422, 435a-435b, 696a; Port. 422, 696a; Span. 400a, 422, 540, 620a-620b, 541, 696a, 696b; Russ. 583, 685.

METALLURGICAL ENGINEERING

Professors William G. Davenport, Head, Louis J. Demer, Kenneth L. Keating, Thomas M. Morris (Emeritus), Daniel J. Murphy (Emeritus), Sigmund L. Smith (Emeritus)
Associate Professor David R. Poirier
Assistant Professors Arturo Bronson, Srini Raghavan, Krishna Seshan

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in metallurgy. Master’s degree students may also elect an interdisciplinary option in materials engineering with a major in metallurgy.

The graduate programs in metallurgy emphasize process metallurgy: the study of the relationships between processing variables and the structure and properties of the resulting material. This includes processing of coal, ores, concentrates, impure metallic and nonmetallic materials, scrap, and ultimately the processing of semifinished materials into useful products. Many aspects of processing are considered, including engineering, design, and control of processes, the study of the structure and properties of the resulting products and the underlying thermodynamics, transport phenomena, kinetics and phase relations involved.

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 metallurgical engineering courses) that is required for the undergraduate curriculum in metallurgical
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 course work including 510. In addition, all students must complete nine additional units of regularly scheduled course work and eight units of thesis. Each student who does not have previous credit for equivalent courses must complete 411, 412, 430aR-430bR, and one of 401R, 420R, 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 224R and 310. Students electing the materials engineering option must, in addition to the requirements set forth above, complete one course from each of the following groups, for a total of nine units: (1) Ch.E. 470; Chem. 642a-642b. (2) A.M.E.-412, 428. (3) E.C.E. 457, 459, 551, 556; Phys. 460; Met. 424, 434.

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 metallurgical 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 metallurgy, but may include economic and design considerations 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.


420L. Process Metallurgy Laboratory (1) GC II Lab. experiments involving application of thermodynamic and transport phenomena fundamentals to metallurgical processes. P, 224R, 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, 224R, 401R, 412.

430aR-430bR. Physical Metallurgy (3-3) GC The structure and behavior of metals and alloys; correlation 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. 433)

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 Testing of Metals** (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 Nu.E. 331.

457. **Integrated Circuit Technology Laboratory** (3) GC I II (Identical with E.C.E. 457)

460. **Health Hazards in the Mine Environment** (2) GC II 1983-84 (Identical with Mn.E. 460)

461. **Accident Prevention in the Mine Environment** (2) GC II 1984-85 (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, Chem. 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)


534. **Advanced Electronic, Magnetic and Optical Materials** (3) II 1984-85 Advanced topics in processing and properties of electronic, magnetic, and optical materials from the metallurgical viewpoint. P, 434. (Identical with E.C.E. 534)

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. Metallurgical Colloquium (1) [Rpt./5] II

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**METEOROLOGY**

*(See Atmospheric Sciences)*

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**MICROBIOLOGY — College of Medicine**

*(See Molecular and Medical Microbiology)*
MICROBIOLOGY

Professors Wayburn S. Jeter, Head, Peter H. Bartels, Rein Kilkson, Peter P. Ludovici, George B. Olson, Irving Yall
Associate Professors Charles P. Gerba, Robert J. Janssen, Norval A. Sinclair, James T. Sinski
Lecturer Lee M. Kelley

The department offers programs leading to the Master of Science, Microbiology Specialist, and Doctor of Philosophy degrees with a major in microbiology. Current departmental research involves aerobiosis, cytochemistry, environmental microbiology, general microbiology, immunobiology, immunonchemistry, microbial physiology, molecular biology, pathogenic microbiology, mycology, tissue and cell culture, and virology.

For admission, the applicant should have completed adequate undergraduate training in microbiology, immunology, chemistry, mathematics, and physics. The applicant must submit scores of the aptitude test of the Graduate Record Examination and three recommendations on forms available from the department.

Degrees

MASTER OF SCIENCE — This program is intended to give a broad academic microbiological background while permitting the student to carry out research in a microbiological or immunological specialty area. It is designed as preparatory for undertaking work leading to the Doctor of Philosophy degree. A thesis is required.

MICROBIOLOGY SPECIALIST — For information concerning this degree program, see Requirements for Specialist Degrees (Specialist in Microbiology) elsewhere in this catalog.

DOCTOR OF PHILOSOPHY — In most instances, completion of the Master of Science degree is prerequisite to admission to this program. The program must include sufficient work in the various fields of microbiology and immunology to assure both breadth and depth of knowledge. The student must also develop high proficiency in the techniques and planning of research in a selected area and proficiency in statistical methods. A knowledge of computer programming is required.

In addition to the courses listed below, the Department of Microbiology is prepared to offer courses in the following areas, subject to faculty availability and student interest: animal virology, advanced pathogenic microbiology, hematology, cellular recognition methodology, immunobiology, aerobiology, and immunonchemistry.

417R. Microbial Physiology (3) GC II Biochemical and physiological activities of microorganisms. P, 217.
417L. Microbial Physiology Laboratory (2) GC II Lab. methods in microbial physiology. P, CR 417R.
418a-418b. Scientific Illustration-Photography (2 to 4 - 2 to 4) GC (Identical with G.Bio. 418a-418b)
419. Introductory Immunology (4) GC I II Principles of serology, humoral immunity and cell-mediated immunity. 3R, 4L. P, four units of micr., Chem. 241b, 243b.
420. Pathogenic Microbiology (4) GC I II Characteristics, isolation and identification of microorganisms pathogenic for men and animals. 3R, 4L. Advanced degree credit available for nonmajors only. P, four units of micr., Chem. 241b, 243b. (Identical with V.Sc. 420)
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 Cell. 428R)
Advanced Microbial Genetics Laboratory (2) GC II (Identical with Cell. 428L)

Introductory Virology (3) GC II Essential features of viruses, Chlamydiae and rickettsiae and their relationships to the diseases of man, animals, plants and microorganisms. P, 4 units of micr., Chem. 241b, 243b.

Introduction to Biophysics (2) GC I (Identical with Phys. 430)

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

Soil Microbiology (3) GC I (Identical with S.W.E. 435)

Control of Infectious Disease (3) GC II Factors involved in the occurrence and prevention of epidemic diseases in the community. P, 419 or 420.

Medical Mycology (4) GC II The isolation and identification of fungi of medical importance. 2R, 6L, P, 103 or 110. (Identical with V.Sc. 450)

Food Microbiology and Sanitation (3) GC II (Identical with N.F.S. 470)

Food Microbiology and Sanitation Laboratory (2) GC II 1984-85 (Identical with N.F.S. 471)

Parasitology (4) GC S (Identical with G.Bio. 489)

Quantitative Microbiology (2) I Theory, design, and application of the instruments employed in microbiological research. P, twelve units of micr.

Tissue Culture (3) II 1984-85 Techniques for the in vitro study of cells and tissues; research application. 1R, 6L, P, four units of micr.

General Virology (4) I Chemical and physical properties of viruses; the viral replication cycle; cellular response to infection. 3R, 4L, P, 328, 419, Chem. 460.

Biophysical Theory (2) II (Identical with Phys. 530)

Molecular Mechanisms of Microbial Pathogenesis (3) II 1984-85 (Identical with M.Mic. 550)

Advanced Microbial Physiology (2) I 1983-84 Studies of metabolic pathways of selected microorganisms with an emphasis on industrial applications. P, 417R.

Seminar
a. Current Problems in Molecular Biophysics (1) I II (Identical with Phys. 596a, which is home)

Experimental Surgery (2) II (Identical with V.Sc. 601)

Immunology (4) II 1984-85 Immunological and immunochemical concepts and techniques. 2R, 6L, P, twelve units of micr., Chem. 460 or N.F.S. 406a.

Recent Advances in Genetics (2) I (Identical with Gene. 670)

Food Safety (2) I 1983-84 (Identical with N.F.S. 672)


Colloquium
a. Readings in Microbiology (1 to 4) [Rpt.] I II

Seminar
a. Research Seminar (1) [Rpt.] I II

MINERAL ECONOMICS
(See Mining and Geological Engineering)

MINING AND GEOLOGICAL ENGINEERING

Professors Jay C. Dotson, DeVerle P. Harris, Y. C. Kim, Richard Newcomb, William C. Peters (Emeritus), Michael Rieber

Associate Professors Charles E. Glass, Head, Jack J. K. Daemen

Assistant Professor Pinnaduwa Kulatilake

Lecturer Harry F. Hillman
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, and the development of new extractive techniques. Advanced work in geological engineering is directed toward the fields of mineral exploration, ground stabilization, earthquake engineering, urban planning, 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 recommends that scores on the Graduate Record Examination (including the Advanced Engineering Examination for mining engineering and geological engineering students) be submitted by all applicants, particularly those seeking financial aid.

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 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.

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** (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 1983-84 (Identical with Mn.E. 460)
461. Accident Prevention in the Mine Environment (2) GC II 1984-85 (Identical with Mn.E. 461)

506. Site Examination and Testing (3) II 1984-85 Correlation of geology with requirements for foundations, dams, testing of soil and rock conditions, methods of support and ground control, case histories of failures. Field trip. P. 425.

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 1984-85 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 1983-84 Integrated approach to ore search involving modeling, decision making, and sequential field operations. 1R, 6L. P. 438.


660a-660b. Estimation of Mineral Resources by Quantitative Methods (3-3) 1983-84 (Identical with Mn.Ec. 660a-660b)

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)

426. Minerals and Environmental Conservation (3) GC I 1984-85 (Identical with Mn.E. 426)


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.

580. Economics of the Nonmetals (3) II 1984-85 Technology of production of 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, externalities, 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.

651. Quantitative Models and Analysis in Mineral Economics (4) I 1983-84 Morphology and structure of economic models, estimation procedures for multiple equation models, data problems, violations of assumptions, and case studies of econometric models in the analysis of mineral industries. P. Econ. 422; 501a or A.Ec. 504; Mn.Ec. 500, 550, 560, 584 or 586.

DEPARTMENTS AND COURSES OF INSTRUCTION

665. Forecasting for Mineral Industries (4) II Methods for short- and long-term forecasting applied to mineral industries; trend analysis, simple econometric models, exponential smoothing, and input-output analysis; case studies. P., Econ. 361; Stat, 660, Econ. 422, or S.I.E. 420; Mn.Ec. 500, 550, 560, 584, or 586.

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

426. Minerals and Environmental Conservation (3) GC I 1984-85 Importance of producing minerals and of maintaining a suitable environment; impact of mining on environment; management of mine wastes and reclamation practices. Field trips. (Identical with Mn.Ec. 426) Dotson

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 1984-85 Application of geomechanical 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 1983-84 Application of geomechanical principles to geotechnical engineering problems: tunneling and underground construction, rock slope engineering, foundations on rock. All-day field trip. P., 427.

460. Health Hazards in the Mine Environment (2) GC II 1983-84 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 Met. 460 and G.En. 460)

461. Accident Prevention in the Mine Environment (2) GC II 1984-85 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 Met. 461 and G.En. 461)

500. Economics of Mineral Resource Development and Production (4) I (Identical with Mn.Ec. 500)


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


MOLECULAR AND MEDICAL MICROBIOLOGY

Professors John Spizizen, Head; Harris Bernstein, William Meinke, David Mount, Dianne Russell (Pharmacology)
Associate Professors George T. Bowden (Radiology), Eugene Gerner (Radiology), Junetsu Ito, Thomas Lindell (Pharmacology), David O. Lucas, Bruce Magun (Anatomy), Frank Myskens (Medicine)
Assistant Professors Ruthann Kibler, John Little (Biochemistry), Richard Rest

Graduate study in the Department of Molecular and Medical Microbiology, College of Medicine, is concerned primarily with the nature, synthesis, and function of biological structures at the molecular and supramolecular levels. Areas of current research emphasis in the department are virology, genetics, immunology, and bacterial pathogenesis. Course programs are drawn from offerings in biochemistry, biological sciences, chemistry, mathematics, microbiology, molecular biology, anatomy, pharmacology, genetics, and others.

Master of Science and Doctor of Philosophy degrees with a major in molecular biology are offered by a program whose faculty includes members from anatomy, microbiology, medicine, pharmacology, and radiology.

Applicants are required to submit scores on the aptitude and advanced tests of the Graduate Record Examination. Three letters of recommendation are also required.

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, G.Bio. 101b, Chem. 241b, Bioc. 501.

540. Topics in Microbiology (1) [Rpt.] I II Variable content. Open to majors only.

550. Molecular Mechanisms of Microbial Pathogenesis (3) II 1984-85 Review of current concepts in specific areas of microbial pathogenesis, including action of exo- and endotoxins, cell surface interactions, phagocytosis and host microbial functions. P, Bioc. 460. (Identical with Micr. 550)

555. Cancer Biology (3) II 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)


581. Immunobiology (3) I II 1984-85 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. Lucas

570. Molecular Genetics (3) I 1983-84 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 use in analysis of gene structure and regulation. Mount/Bernstein


580. Molecular Virology (3) II 1983-84 The current status of basic research in virology at the molecular level. P, Chem. 460. Meinke

595. Colloquium a. Molecular Biology (1) [Rpt./2] II
222. DEPARTMENTS AND COURSES OF INSTRUCTION

596. Seminar
   a. Molecular and Cellular Immunology (1) I II
   b. Immunopathology (1) I II
   c. Molecular Genetics of Microorganisms (1) I II
   d. Tumor Virology (1) I II
   e. Host-Parasite Interactions (1) I II
   f. Control of Proliferation in Animal Cells (1 to 2) I (Identical with Radi. 596h, which is home.)

MUSIC


Associate Professors Koste A. Belcheff, Gary D. Cook, John A. Denman, Elizabeth Thompson Ervin, John R. Fitch, Keith M. Johnson, Jean-Louis Kashy, James Keene, Rodney M. Mercado, Michael Rogers

Assistant Professors Terry Barham, Paula Fan, Jeffrey Haskell, Carrol McLaughlin, Karl Miller, Thomas Patterson, Jeffrey Showell

Lecturers Curtis Burris, Thomas R. Ervin, Alexander Heller, Dana Rothlisberger

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.

423. Band Arranging (2) GC II 1983-84 Detailed study of band instrumentation; major works transcribed for concert band. P. 421.

430a-430b. Art Song Repertory (2-2) GC 1984-85 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 1983-84 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. 2R, 3L.

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 prerequisite to 433b.

434. History and Literature of Guitar. (3) GC II 1983-84 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 qualitative 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.

500. Graduate Study in Conducted Ensemble (1) [Rpt.] I II Techniques and literature.
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

501. Chamber Ensemble (1) [Rpt.] I II Study and performance in small ensembles; regular coached meetings, rehearsals and public performances. P, audition or permission of instructor.
a. Accompanying
b. Brass Ensemble
d. Brass Choir
e. Percussion Ensemble
f. Contemporary Ensemble
g. Guitar Ensemble
h. Clarinet Choir
j. Jazz Combo
o. Musical Theatre
p. Piano Ensemble
q. Saxophone Ensemble
s. String Ensemble
w. Woodwind Ensemble
x. Pep Band

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 1983-84 Vocal and instrumental genres from Dufay through Palestina. Open to majors only.

531. Music in the Baroque (3) I 1983-84 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 1984-85 The Viennese classical tradition from its origins to Beethoven. Open to majors only.

533. Music of the Twentieth Century (3) II 1984-85 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) I S Intensive survey of music history from Gregorian chant to the late Baroque. Open to majors only.
550. **Advanced Studies in General Music Teaching** (3) I S Development of musical concepts through creative experiences; survey of research into music learning in children; alternative systems: Dalcroze, Orff, Kodaly, MCCP. P, 361 or 451.

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 L.I.S. 600)

605. **Advanced Opera Theatre** (1 to 4) [Rpt.] I II Advanced training in all aspects of operatic production, including major singing roles (when appropriate), 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.

620a-620b. **History of Speculative Theory** (3-3) 1983-84 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 1984-85 Study of the philosophies, procedures, techniques, and materials used in teaching theory at the college level.


630. **The Music of Bach** (3) II 1984-85

631. **The Music of Mozart** (3) II 1983-84

640. **Advanced Composition** (2 to 6) [Rpt.] I II Individual projects in composition. Open to theory and composition majors only.

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 1984-85 Principles and techniques of curriculum construction applied to the field of music.

652. **The Administration of Music Education** (3) II 1983-84 Financing, scheduling, selecting personnel and equipment, supervising instruction, maintaining desirable public relations, evaluating and administering the total school music program in a school district, city, county, or state. P, 650.

653. **The Music Cultures of Asia and Oceania** (3) I 1984-85 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.

696. **Seminar**
   a. Music Education (1 to 6) I II
   b. Musicology (1 to 6) I II
   c. Music Theory (1 to 6) I II

**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)

- **VOICE**
  - 580-V (1 to 2); 685-V, 785-V (1 to 4)

- **ORGAN**
  - 580-O (1 to 2); 685-O, 785-O (1 to 4)

- **CONDUCTING**
  - 685-Cg, 785-Cg (1 to 4)
**STRING INSTRUMENTS**

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**HARPSICHORD**

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**PERCUSSION INSTRUMENTS**

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**MUSIC EDUCATION**

*(See Music)*

**MUSICOCOLOGY**

*(See Music)*
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 Professors Leland M. Montierth, Daniel Morrison

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 I 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.

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)

454. **Dynamics of Nuclear Systems** (3) GC I Nuclear reactor kinetics, integral transform methods, internal feedback effects, stability; reactor instrumentation and control. P, 343.

463. **Energy from Biomass** (3) GC II (Identical with S.W.E. 463)

465. **Current Problems in Energy and Power** (1 to 4) 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 A.M.E. 465, 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 II 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).

477. Environmental Impact of Energy-Related Systems (3) GC II (Identical with C.E. 477)


530. Radiochemistry and Radiation Detection (3) I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. 2R, 3L. P, Chem. 480b or Phys. 230. (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.

554. 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 A.M.E. 566, Ch.E. 566, and E.C.E. 569)

577. Management of Research and Development Activities (3) I Review of the fundamental philosophy of human organization; survey of the forms and functioning of human organizations; organization for creative accomplishment; principles of design for formulation of organizational mechanisms and practices.

583a-583b. Plasma Physics and Thermonuclear Theory (3-3) 583a: I 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)

596. Seminar s. Advanced Nuclear Power Activities (1) I II


630. Fuel Cycles for Nuclear Reactors (3) II 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 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 Selected topics in nuclear system dynamics, simulation and control; content varies. P, 454.

671. Numerical Methods in Nuclear Engineering (3) I 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) 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. Couler (Emerita), Ada Sue Hinshaw, Margarita A. Kay, Beverly A. McCord, Arlene M. Putt (Emerita)

Associate Professors Dyanne Affonso, Helen C. Chance, Evelyn M. DeWalt, Josephine R. Gibson, Mary E. Hazzard, Daniel Levinson, Alice J. Longman, Lillian Lynch (Emerita), Betty J. McCracken, Virginia J. Miller, Merle Mishel, Alice L. Noyes, Jessie V. Pergrin, Lois E. Prosser, Gayle A. Traver, Mary J. Welty, Mary O. Wolanin (Emerita), Katherine J. Young

Assistant Professors Catherine Haynes, Thelma Hostetler, Ramona Johnson, Patricia King, Gerri Lamb, Mary MacKinnon, Katherine A. Mason (Emerita), Carolyn Murbaugh, Dona Pardo, Linda Phillips, Pamela Reed, Judith Shaw, Joyce Verran

Lecturers Doris Abbott, Jacqueline Barth, Patricia J. Barton, Mary Davis, Phyllis L. Dow, Janet Gruner, Karen Ehrat, S. Cloud Hseuh, Julia B. Hubley, Helen L. Navin, Marla Perry, Julia Robinson, Kaye Ronsman, Mary Ryan, Julie Schmidt, Evelyn Shaw, Mary Kay Simon, E. Jean Snyder

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) skills in physical assessment.

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, gerontology, maternal-newborn, medical-surgical, and psychiatric-mental health nursing. An occupational safety and health emphasis is available within the community health concentration. 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 gerontology, maternal-newborn, or medical-surgical nursing must include a graduate course in human physiology.

The time required for completion of degree requirements is at least two regular semesters plus one summer. 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 potentials 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, BSN.

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) I II 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 outcomes. Approaches to and psychological reactants of evaluation are explored.

620. 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.

624. 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.

625. Physiological Concepts: Nursing (3) I Physiological, endocrinological, and/or biochemical concepts and principles relevant to understanding oral contraception, menopause, depression, and water and electrolyte balance.
630. **Methods in Nursing Research** (3) I Critical examination of selected problems and methods in the nursing research process. P, 600a or CR.

631. **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.

680a-680b. **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.

681. **Dynamics of Behavior in Patients with Chronic Disease** (2) I Behavioral problems of individuals with chronic diseases and ways of intervening. Open to majors only.

705. **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 psio., six units of an adv. social sci.

710. **Clinical Nursing Research** (3) I Investigation of selected strategies appropriate to researching problems in clinical nursing. P, 600a-600b-600c, 602, 705, 630.

771. **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.

775. **Study of Social Influences** (3) S 1984 In-depth examination of social forces affecting the health care system.

782a-782b-782c. **Field Work in Nursing Research** (3-3-3) S I II Individualized course of study incorporating research and clinical knowledge in a selected area of nursing practice in the laboratory and field setting. P, 600a-600b-600c, 602, 630, 705, 710.

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**NUTRITION**

*(See Nutrition and Food Science, Nutritional Sciences)*

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**NUTRITION AND FOOD SCIENCE**


Associate Professors Don P. Bourque, Charles P. Gerba, Gail G. Harrison, K. Y. Lei, Ralph L. Price, Edward T. Sheehan, Alice B. Stanfield (*Emerita*)

Assistant Professors Ronald E. Allen, Patsy M. Brannon, James F. Deatherage, Roger A. Sunde, Ann M. Tinsley, Donald L. Zink

Lecturers Stewart Christensen, Betty Jordan, Barbara J. Zeches

The Department of Nutrition and Food Science is concerned with advanced training in the areas of home economics*, 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 through courses and research direction for students working toward the Master of Science or Doctor of Philosophy degrees with majors in nutritional sci-
ences, 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 upon experimental work is required for the food science major, Master of Science degree. Students in the dietetics major may choose a thesis or non-thesis option. The thesis option requires 30 units (a maximum of six units may be from the department's A.D.A.-approved internship), and 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 major is currently under review. For further information, contact the School of Home Economics.

406a-406b. Nutritional Biochemistry (3-3) GC The biochemical aspects of nutrient metabolism in animals, with emphasis on nutrient interrelations. P. Chem. 241a-241b. McCaughey

406. Human Nutrition (3) GC I Concepts of the physiology and biochemistry of nutrients and nutrient homeostasis in humans. P. 406a-406b or Bioc. 460, G.Bio. 159a-159b, CR 464a. Lei

430. Principles of Nutrition (3) GC I II (Identical with An.S. 430)

441. Therapeutic Nutrition (4) GC II 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. Experimental Food Study (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. Institution Organization and Administration (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 1983-84 Fundamentals of taste, odor, color, and rheology perception as related to food; design and methodology of small-panel and consumer-panel testing. 2R, 3L. Stull/Angus


466. Postharvest Physiology (3) GC II 1983-84 (Identical with PLS. 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 1984-85 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 1983-84 (Identical with An.S. 480)

485. Dairy Products Processing (3) GC I 1983-84 Principles of processing butter, cheese, condensed milk, dehydrated milks, frozen desserts, and special products; selection and preparation of materials. Stull

538. Problems in the Biochemistry of Aging (2) I 1984-85 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
560. **Advanced Food Chemistry (3)** I 1983-84 Chemical and physical structure and functions of food constituents, additives, and food properties. P, 360, CR 406a. *Berry*

568a-568b. **Nucleic Acids (3-3)** 1983-84 (Identical with Bioc. 568a-568b)

596. **Seminar**
   cc. Community and International Nutrition (1 to 3) II (Identical with Med. 596cc, which is home)


602. **Metabolic Integration (2)** II Food intake, transport, protein and amino acid utilization in higher animals. P, 408.

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 1983-84 Chemistry and structure of lipids and their digestion, adsorption, transport and utilization; current research in lipid metabolism and the role of lipids in certain disease states. P, 406a-406b. *Marchello*

617. **Steroid Chemistry and Biochemistry (3)** I 1984-85 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) *Kircher*


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*

638. **Theories of Aging (2)** I 1983-84 Theories of aging with regard to biochemical changes in the aging organism and their effects on behavior in the aged human. P, 3 units of bio., chem., phys., or micr. Open to majors in the social or health sciences only. *McCaughey*

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. 1R, 6L, P, 693 or other ADA-approved clinical internship. *Kight*

645. **Nutritional Pathology (3)** I Identification of nutrient-based lesions; diagnosis of causative factors, using clinical, biochemical and dietary data; prognosis for the outcome; recommendation for nutritional prescription. 1R, 6L. Field trips. *Sheehan*

663. **Chemistry of Food Carbohydrates (2)** II 1984-85 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 1983-84 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. *Goll*

672. **Food Safety (2)** I 1983-84 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 (12) I II Field trips. Consult dept. before enrolling. Open to majors only. P, Course work equivalent to American Dietetic Association Plan IV.

696. **Seminar**
   a. Molecular Biology (1 to 2) I II
   b. Nutrition (1) I II (Identical with Nu.Sc. 696b)
   c. Food Science (1) I II
NUTRITIONAL SCIENCES

Committee on Nutritional Sciences (Graduate)


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 bioc., and students in human nutrition must complete three units of psio.

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 bioc., a.ph., psio., cell., g.bio., food sci., anth., pcol., and chem.

Programs for both degrees will emphasize courses from the following listing.

Related Courses

Refer to the appropriate department for course descriptions. Among the courses that are appropriate for students majoring in nutritional sciences are Anat. 601, 602, 603, An.S. 430, 436, 635, Anth. 470a-470b, 665a-665b, Bioc. 462a-462b, 463, 565a-565b, 568a-568b, 569a-569b, 572, Cell. 410a-410b, 412, 413, 416, 417, 456, 457, 530, 612, Chem. 424, 440, 480a-480b, 502, 520, 521, 524, 526, 645, 684, G.Bio. 464aR-464bR, 467R, 558, Micr. 419,
OPTICAL SCIENCES

Committee on Optical Sciences (Graduate)


Associate Professor Martin E. Silverstein (Surgery)
Assistant Professors Eustace L. Dereniak, Ursula J. Gibson, William M. Hetherington III (Chemistry), Chris L. Koliopoulos, Robin N. Strickland (Electrical and Computer Engineering)

Assistant Research Professor Jerome V. Moloney
Lecturer James M. Palmer

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 atmospheric optics, coherent optics, holography, image processing, infrared techniques, integrated optics, laser physics, medical optics, nonlinear optics, 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, Physics, Physiology, Planetary Sciences, Psychology, and Radiology are in progress.

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 Administrator for 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 1984-85 (Identical with Met. 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 1983-84 Metrology of components; aspheric surface testing; assembly and alignment of systems; system evaluation. P, 505.

514. **Aberration Theory** (3) I 1984-85 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. 508.

521. **Polarized Light: Theory and Practice** (3) I 1983-84 Polarized light; mathematical description; interaction with dielectrics and metals; crystal optics; double refraction; polarization devices; matrix treatment; applications. P. 505.

522. **Theory of Partial Coherence and Polarization** (3) I 1984-85 Statistical properties of light; mutual coherence function; the Michelson stellar interferometer; image formation with partially coherent light; cascaded optical systems; resolution; photoelectron statistics; Hanbury-Brown and Twiss intensity interferometry. P. 505.

524. **Optical Data Processing** (3) I 1983-84 Inverse filtering; matched filtering; frequency-domain synthesis; the Vander Lugt filter; shadow-casting correlators; OTF synthesis; coded-aperture imaging. P. 505.

527. **Holography** (3) I 1984-85 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) I 1983-84 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)

538. **Medical Optics** (3) I 1984-85 Imaging methods in radiology, ultrasound, NMR, thermography, planar x-rays, classical tomography, computed tomography, gamma ray emission methods, positron imaging, digital radiography, xerographic methods. P. 502.


541. **Introduction to Lasers** (3) I Laser theory; properties of lasers; stimulated emission; dispersion theory; gain saturation and rate equation; optical resonators; survey of laser types and mechanisms. P. Phys. 103b.

541L. **Introduction to Lasers Laboratory** (1) I Lab. in support of 541. P. CR 541.

542. **Laser Principles and Applications** (3) I Laser design; hazards; frequency-stabilized lasers; line width; parametric conversion; frequency doubling and tripling; modulation of laser beams; coherent detection; applications. P. 541.

542L. **Laser Principles and Applications Laboratory** (1) I Lab. in support of 542. P. CR 542.

543. **Laser Physics** (3) I 1984-85 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)

545. **Nonlinear Optics** (3) I 1983-84 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 1984-85 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 1983-84 Units and nomenclature; Planck's law; black bodies; gray bodies; spectral emitters; Kirchoff's law; flux concepts; axial and off-axis irradiance; radiative transfer; normalization; coherent illumination; radiometric instruments. P. 501.

559. **Infrared Techniques** (3) I 1984-85 The radiant environment; atmospheric properties; optical materials and systems; detector description and use; data processing; displays, systems design and analysis. P. 558.

563. **Photoelectric Imaging Devices** (3) I 1983-84 Intensifiers; camera tubes; electronography; storage tubes; specifications; evaluation; applications. P. Phys. 116.

565. **Radiation Detector Laboratory** (2) I 1983-84 Operational amplifiers, noise, signal processing, photovoltaic and photoconductive detectors, photomultipliers, thermal detectors. 6L. P. 509, CR 566.
566. Optical Detectors (3) II 1984-85 Photoconductors; semiconductors; signal and noise mechanisms; figures of merit; limitations on the sensitivity of detectors; photoemitters; detectors of ionizing radiation. P, 507.


577. Optics of Thin Films (3) II 1984-85 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) II


642. Laser Spectroscopy (3) I 1983-84 Interaction of light with atoms and molecules; the Lamb dip; two-photon spectroscopy; polarization spectroscopy; double resonance; photon echoes; coherent transient effects; density matrix; molecular spectroscopy; laser sources. P, 543 or Phys. 570b.

643. Quantum Optics (3) II 1984-85 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) 1984-85 (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

Professors Robert M. Ginello, Head, Ludwig W. Adamec, Don C. Bailey, Anoop C. Chandola, William G. Dever, Adel S. Gamal, Onnie M. Hartsell (Music), James M. Mahar, Earl H. Pritchard (Emeritus), Hamdi A. Qafisheh, Robert M. Quinn (Art), William R. Schultz, Jing-shen Tao, Allen S. Whiting (Political Science), David J. Woloshin (German)

Associate Professors Gail L. Bernstein, Michael E. Bonine, Constance Cronin (Anthropology), Richard M. Eaton, Leslie A. Flemming, Charles H. Hedtke, Chisato Kitagawa, Ronald C. Miao, Michael Schaller (History), Stephen H. West, William J. Wilson, Norman Yoffee (Anthropology)

Assistant Professors Marie Chan, John Y. Hou, Peter Machinist, William R. Royce, Naomi B. Sokoloff, Daniel Swetschinski

Lecturer Edward D. Putzar

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 dept. before enrolling. (Identical with Reli. 421a-421b)


432. Islamic Mysticism (3) GC II 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 1984-85 (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)

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.

410a-410b. Advanced Modern Chinese (5-5) GC Study of advanced modern (Mandarin) Chinese through readings in modern literature and newspapers. P. 400b.

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 dept. 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 dept. 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)

440. Chinese Calligraphy (2) GC [Rpt.] I 1983-84 Theory, practice, and aesthetics of Chinese brush writing, with emphasis on individual training and development.
443. **Chinese Aesthetics (2)** GC II Survey of traditional Chinese aesthetic concepts in language, literature, painting, calligraphy, and design.

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 Pol. 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 Pol. 461a-461b)

485. **Traditional Chinese Political Institutions (3)** GC I Survey of traditional political institutions and culture of China, with emphasis on the Ch’ing period.

475a-475b-475c-475d-475e. **Periods in Chinese History (3-3-3-3-3)** GC In-depth treatment of major pre-modern 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)

476. **Modern Chinese History (3)** GC Historical survey of the period since 1911 which examines the revolutionary developments shaping contemporary China. (Identical with Hist. 476)

482. **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)

495. **Colloquium**
a. Revolution in Chinese History (3) GC II (Identical with Hist. 495a)

500a-500b. **Literary Chinese (3-3)** Introduction to pre-20th-century Chinese styles through readings in classical Chinese literature. P. 410b.

510a-510b. **Chinese Historical Linguistics (3-3)** II 1984-85 Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P. 400b and a course in general ling.

520. **Resources and Methods in Sinology (3)** II 1983-84 Introduction to and exercises in the use of standard Sinological reference and research resources. P. 500b.

550. **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. P. 410b.


553. **Readings in Classical Chinese Prose (3) [Rpt./2]** I 1983-84 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. P. 500b.

554. **Readings in Modern Chinese Literature (3) [Rpt./2]** I II Readings in Chinese literature since 1900. Variable content drawn from short stories, novels, drama, and poetry. P. 410b.


570. **Chinese Historical Texts (3) [Rpt./2]** II 1984-85 Readings in traditional historical texts of various types. P. 500b.

595. **Colloquium**
a. China (3) [Rpt.] I II

596. **Seminar**
f. Classical Chinese Literature (3) [Rpt.] I II
g. Modern Chinese Literature (3) [Rpt.] I II
h. Premodern Chinese History and Politics (3) [Rpt.] I II
i. Modern Chinese History and Politics (3) [Rpt.] I II

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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 1984-85 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 I II 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 1984-85 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 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 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)

486. Political Systems of India and Pakistan (3) GC II Survey of postindependence political developments in Pakistan and India. (Identical with Pol. 486)

501. Advanced Hindi-Urdu (3) [Rpt.] Advanced conversation, writing and reading of modern prose, with separate sections for written Hindi and written Urdu.

595. Colloquium
   c. South Asia (3) [Rpt.] I II

596. Seminar
   u. Case and Paninian Grammar (3) [Rpt.] I II (Identical with Ling. 596u)

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Japan

Prior to registering in any Japanese language course, the student must demonstrate the minimum knowledge of Japanese recommended by the instructor.

402a-402b. Intermediate Japanese (5-5) GC Grammar, reading, and conversation in the modern language.

411a-411b. Modern Japanese Grammar (3-3) GC Introduction to Japanese linguistics: morphology, syntax, semantics, and pragmatics. (Identical with Ling. 411a-411b)

412a-412b. Advanced Japanese (5-5) GC Reading from modern scholarship, fiction, and essays, with attention to grammatical analysis.

437. Japanese Religion (3) GC I Japanese Buddhism, Shinto, new religions, with emphasis on the period since 1600. Reading is in English; basic knowledge of Japanese history required. (Identical with Reli. 437)


474a-474b-474c. History of Japan (3-3-3) GC Social, cultural and political history of Japan. 474a: From earliest times to 1500. 474b: 1500-1800. 474c: 1800-present. (Identical with Hist. 474a-474b-474c)

495. Colloquium
   b. Japan (3) GC [Rpt./2] I II

502. Literary Japanese (5) 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.] I II

596. Seminar
   r. Japanese History (3) [Rpt.] I II
   s. Japanese Literature (3) [Rpt.] I II
Judaic Studies

401. Ancient Mesopotamia (3) GC I 1984-85 (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 1984-85 (Identical with Anth. 427)

428. Anthropology of Law (3) GC II 1984-85 (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 1983-84 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.


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 1983-84 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 1984-85 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)

448. Arabic Literature in English (3) GC II 1983-84 Historical survey of Arabic literature of the Middle East and Mediterranean world, with readings in English translations.

449. Persian Literature in English (3) GC II 1984-85 Historical survey of Persian literary traditions, with readings in English translations.

457. Prehistoric Mesopotamia (3) GC I 1983-84 (Identical with Anth. 457)

458. Government and Politics of the Middle East (3) GC II (Identical with Pol. 458)

459. Topics in Economic Geography of the Middle East (3) GC II (Identical with Geog. 459)

469. Geography of the Middle East (3) GC I Physical environments and cultural areas of Southwest Asia, with emphasis on man-environment interrelationships, settlement systems and impact of Islam. (Identical with Geog. 469)
477a-477b. History of the Middle East (3-3) 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)

478. Modern History of the Middle East (3) 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)

479. The Ottoman Empire to 1800 (3) GC II 1984-85 Great age of the Ottoman state, its origins and decline. (Identical with Hist. 479)

480a-480b. History of Iran and Central Asia (3-3) GC 480a: History of Iran from 226 A.D. to 1722. 480b: 18th, 19th and 20th century Iran. (Identical with Hist. 480a-480b)

481a-481b. Archaeology of Syria-Palestine in the Bronze and Iron Ages (3-3) 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)

484a-484b. Akkadian Linguistics (3-3) GC 1983-84 (Identical with Anth. 484a-484b)

584a-584b. Readings in Akkadian (3-3) 1983-84 (Identical with Anth. 584a-584b)

595. Colloquium
   d. Middle East (3) [Rpt.] I II

596. Seminar
   m. Middle East Historiography (3) [Rpt.] I II
   p. Middle Eastern Urbanism (3) [Rpt.] I II
   q. Near Eastern Archaeology (3) [Rpt.] I II (Identical with Anth. 596q)

PALEONTOLOGY
(See Geosciences)

PERFORMANCE
(See Music)

PERSIAN
(See Oriental Studies)

PHARMACEUTICAL SCIENCES

Associate Professors James Blanchard, Michael B. Mayersohn
Assistant Professors Joseph J. Hoffmann (Arid Lands Resource Sciences), Karl H. Schram

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 II Principles of antibiotic chemotherapy and the properties of the natural antibiotics employed in therapeutics and growth control. P, Micr. 110.

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 I 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.

475. Pharmacotherapeutics (11) GC I (identical with Ph.Pr. 475)


575. Advanced Pharmacotherapeutics (6) II (identical with Ph.Pr. 575)

596. Seminar
   a. Pharmaceutical Sciences (1) [Rpt./5] I II
   b. Pharmaceutical Chemistry Research (1) [Rpt./5] I II
   c. Pharmaceutics Research (1 to 2) [Rpt./5] II Open to majors only.

602. Physical-Chemical Properties Influencing Drug Action (4) II 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) Rational drug design, receptor site theories, mechanism of drug action, and metabolic pathways of medicinal agents; chemical and enzymatic synthesis of important pharmaceutics. P, 437b, Pcol. 471b.

632a-632b. Natural Medicinal Products (3-3) Origin and isolation of steroidal and alkaloidal drugs and other natural products of interest. P, 437b, Pcol. 471b.

634. Biomedical Applications of Mass Spectrometry (3) II 1983-84 Principles of mass spectrometry including instrumental design, interpretation of spectra, and applications to biomedical and related problems. P, Chem. 241b
PHARMACOLOGY AND TOXICOLOGY

Committee on Pharmacology and Toxicology (Graduate)

Professors I. Glenn Sipes Chairperson, Klaus Brendel, Thomas F. Burks, Lincoln Chin, Diane H. Russell
Associate Professors Dean E. Carter, Hugh E. Laird, II, Sue Piper Duckles

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 Chairman 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.

PHARMACOLOGY

(Department, College of Medicine)

Professors Thomas F. Burks, Head, David S. Alberts (Internal Medicine), H. Vasken Aposhian (Cellular and Developmental Biology), Klaus Brendel, Rubin Bressler (Internal Medicine), Bernard B. Brodie (Visiting), 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, Sue Piper Duckles, Thomas J. Lindell, John D. Palmer, William R. Roeske (Internal Medicine), Stuart R. Snider (Neurology)
Assistant Professors Thomas P. Davis, John J. Duffy (Adjunct), Raymond C. Duhamel (Adjunct), Timothy C. Fagan (Internal Medicine), David L. Kreulen, Ronald J. Lukas (Adjunct), Paul R. Marques (Adjunct), Thomas L. Smith (Adjunct)

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 above 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 dis-
ease and the promotion of optimal health. The emphasis of 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, Pslo. 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.


581a-581b. 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 Psoc. 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.

596. Seminar
   a. Advanced Graduate Research (1 to 3) [Rpt./3] I II P, 561b. (Identical with Psoc. 596a)

601. Analytical Toxicology (2 to 3) I (Identical with Tox. 601)

602. Biotoxicology (2 to 3) II (Identical with Tox. 602)

653. Neuropharmacology (2) II 1984-85 (Identical with Psoc. 653)

654. Psychopharmacology (3) 1983-84 (Identical with Psoc. 654)

695. Colloquium
   a. Cellular/Molecular Pharmacology (1 to 3) [Rpt./4 units] I II P, Bioc. 462a-462b; Cell. 568a-568b and/or PhcL 551.

PHARMACOLOGY AND TOXICOLOGY

(College of Pharmacy)

Professors I. Glenn Sipes, Head, Lincoln Chin, J. Wesley Clayton, Paul F. Consroe, Albert L. Picchioni, Findlay E. Russell

Associate Professors Dean E. Carter, Hugh E. Laird, II

Assistant Professors David L. Nelson, 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 molecular reactions of drugs with chemical constituents of cells 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

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 (5-5) 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, Psio. 480, 481; Anat. 401; CR Ph.Sc. 437a-437b. (Identical with Tox. 471a-471b)

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, 372b or 471b, Ph.Pr. 475, Ph.Sc. 407. (Identical with Tox. 474)

475. Pharmacotherapeutics (11) GC I (Identical with Ph.Pr. 475)

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 1984-85 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

Toxicology

The interdisciplinary toxicology program is coordinated by the Committee on Toxicology. The program 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)


454. Industrial Toxicology (2) GC II Principles of toxicology related to industry; dose response, mechanisms of toxicity; Toxic Substances Control Act, federal and state regulations; combustion toxicology. P, six units each of bio. sci. and organic chem. (Identical with O.S.H. 454)

462a-462b. Biochemistry (3-3) GC (Identical with Bioc. 462a-462b)

464aR-464bR. Human Physiology (3-3) GC (Identical with G.Bio. 464aR-464bR)

464aL-464bL. Human Physiology Laboratory (1-1) GC (Identical with G.Bio. 464aL-464bL)

465. Statistics for the Medical Sciences (4) GC I (Identical with Stat. 465)
PHARMACY PRACTICE

Professor Theodore G. Tong
Associate Professors William F. McGhan, Gary H. Smith
Lecturers Jack R. Arndt, James R. Morse

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.

An undergraduate degree in pharmacy 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.

440. Pharmacy in the Health Care System (3) GC II Consumers, providers, financiers, and regulators of health care in the U.S. and exploration of pharmacy's roles in relation to these components.

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. P, 440.

447. Perspectives in Geriatrics Laboratory (1) GC II Open to nonmajors. P, CR 448. (Identical with 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 N.F.S. 448)

455. Introduction to Clinical Pharmacy (4) GC I Clinical evaluation of drug utilization related to specific diagnosis and desired therapeutic response; consultation with physicians, nurses and patients; solving specialized drug problems. P, 394, Ph.Sc. 409, Pcol. 470b, 471b, CR 475.


503. Clinical Clerkship
a. Externship (4) I II S P, grad. students consult dept. before enrolling.
b. Adult Pharmacy Practice (4) I II S P, grad. students consult dept. before enrolling.
c. Ambulatory Pharmacy Practice (4) I II S P, grad. students consult dept. before enrolling.
d. Drug/Poison Information (4) I II S P, grad. students consult dept. before enrolling.

Note: 503a-d are six week courses.

511. Hospital Pharmacy Administration (3) I History, organization and administration of pharmaceutical services within the institutional environment.

512. 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.

557. 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.

561. 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.

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)

596. Seminar
a. Pharmacy Practice (1) [Rpt./5] I II
b. Pharmacy Practice (Hospital) (1) [Rpt./5] I II

611a-611b. Pharmacy and Its Environment (3-3) 1983-84 Cultural, social, behavioral, and organizational foundations of pharmacy, including the development of the present state of practice.

612a-612b. Issues in Pharmacy Practice Research (3-3) 1984-85 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.

621. Pharmaceutical Marketing (3) II Socioeconomic factors in the development, production, and distribution of drugs.

694. 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, Frank A. Lewis

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. Doctoral students must pass a qualifying examination and demonstrate proficiency in logic.

402. Mathematical Logic (3) GC II 1983-84 (Identical with Math. 402)
403. Foundations of Mathematics (3) GC II 1984-85 (Identical with Math. 403)
410. Philosophy of the Physical Sciences (3) GC II Philosophical problems regarding space, time, motion, relativity, causality, measurement, theoretical entities.
411. Philosophy of the Biological Sciences (3) GC I 1983-84 Laws and models in biology, structure of evolutionary theory, teleological explanations, reductionism, sociobiology. (Identical with Ecol. 411)
415. Philosophy of Action (3) GC II 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.
420. Ethical Theory (3) GC II Nature and justification of ethical judgments and principles.
422. Linguistic Semantics and Lexicology (3) GC II 1984-85 (Identical with Ling. 422)
424. Philosophy of Psychology (3) GC II 1983-84 Investigation of philosophical issues arising from current work in psychology including perception, reasoning, memory, motivation and action.
425. Advanced Symbolic Logic (3) GC II 1984-85 Investigation of some major results in logic, such as Lowenheim-Skolem, Godel, Church and Tarski’s theorems, and their philosophical import.
426. Introduction to Nonstandard Logic (3) GC II 1983-84 Introduction to modal logic; problems of interpretation and application; extensions to such areas as tense logic, epistemic logic, deontic logic.
431. Metaphysics (3) GC I Topics include free will and determinism; causation; personal identical; and universals.
432. Theory of Knowledge (3) GC I Critical examination of some of the major problems concerning evidence, justification, knowledge, memory, perception and induction.
434. Social and Political Philosophy (3) GC I Fundamental concepts of politics; leading social and political theories, such as anarchism, social contract, Marxism.
439. Analytical Philosophy of Religion (3) GC II 1984-85 Effect of analytical and linguistic philosophy on basic questions of religious truth, the meaning of religious and theological statements, and the way in which religious discourse may be understood. (Identical with Reli. 439)
460. Greek Philosophy (3) GC [Rpt.] II Topics in Greek philosophy, to be selected from Plato (Earlier or Later Dialogues) and Aristotle.
461. Rationalism and Empiricism (3) GC II 1983-84 Survey of main controversies among rationalists and empiricists of the 17th and 18th centuries.
462. Problems in 17th- and 18th-Century Philosophy (3) GC [Rpt.] II 1984-85 Intensive study of selected issues in the philosophy of one or two of the following: Hobbes, Locke, Berkeley, Hume, Descartes, Spinoza, Leibniz, Kant.
PHYSICAL EDUCATION

Professors Anne E. Atwater, Acting Head, Donna Mae Miller, Frederick B. Roby, Mary P. Roby, Jack H. Wilmore, John M. Wilson


Assistant Professors Anne L. Binkley, Victor A. Convertino, Roger M. Enoka, James H. Gramann, Nina Janik, Mary K. Wolff

The department offers programs leading to the Master of Science and Master of Arts degrees with a major in physical education. A minor in physical education 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 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 two letters of recommendation, from persons in a position to evaluate the applicant's potential as a graduate student, sent directly to the Coordinator of the Graduate Program of the Department of Physical Education.

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 twenty units must be completed in physical education, but students are encouraged to take work in related fields as well if it is directed toward research interests. The preparation of a thesis is optional, but a student who chooses to present one may earn as many as six units for its preparation. In the thesis option, the student must complete a minimum of thirty 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 and close personal supervision of thesis research and writing are available.

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**
   a. Dance-Related Art Forms (1 to 3) GC II 1984-85 *Bergsohn/Wilson*
   b. Analysis of Data in Human Motion Studies (1) GC I II *Atwater*


503. **Therapeutic Recreation Processes** (3) II Relationships of all components of a therapeutic recreation service such as resources, facilities, and personnel. P, 325 or 427.

505. **Commercial Recreation** (3) I Introduction to profit-oriented recreation agencies and factors which contribute to their financial success, including design, planning, development, management and marketing.

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 ph.ed. *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, G.Bio. 159a-159b, twelve upper-division units of ph.ed. *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*

527. **Psychological and Social Parameters Affecting Sports Performance** (3) I Examines the effects of motivation, personality, aggression, anxiety and anxiety management techniques, attitudes, competition and social influence processes on sport performance and the influence of physical activity/fitness on psychological well-being. *Williams*

530. **Advanced Physiology of Exercise** (3) I Study of metabolic, cardiorespiratory, thermoregulatory, fluid-electrolyte, neuroendocrine, neuromuscular and various environmental factors which influence the performance of muscular activity during acute exercise and the physiological adaptations to chronic exercise. P, 373. *Convertino/F. Roby/Wilmore*

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 ph.ed. *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*

540. **Motor Development and Skill Acquisition in Children and Young Adults** (3) II Motor development and the progressive changes in motor behavior and motor skill acquisition from infancy through young adulthood. P, 279.

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. **Laboratory Techniques for Exercise Physiology** (3) II Instrumentation and techniques used in measuring the physiological responses of human subjects during exercise stress. *F. Roby/Wilmore*

555. **Cinematographic Techniques for Analyzing Human Movement** (3) II High-speed motion picture photography applied to the study of human motion; techniques of data collection, reduction, analysis and interpretation. P, 520. *Atwater*

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.

570. **Research Design in Physical Education** (2) I II Special emphasis on research orientation; study of areas of research and methodology pertinent to physical education; selection of research problems and preparation of thesis. *Fairchild*
580. Recognition of Athletic Injuries (3) I Advanced study of the etiology, pathology and manifestations of common athletic injuries, with emphasis on specific techniques of injury recognition by the athletic trainer. P, 377; 800 hrs. of clinical experience in athletic training. Delforge

581. Reconditioning of Athletic Injuries (2) II Advanced study of the use of hydrotherapy, electrotherapy and massage in the rehabilitation of athletic injuries. P, 580. Delforge

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. Therapeutic Exercise (3) II Role of exercise in the rehabilitation of common athletic injuries; principles in the development and application of therapeutic exercise programs for injured athletes. P, 580. Delforge

585. Current Problems in Athletic Training (3) S Current problems in athletic training and sports medicine; organization and administration of athletic training programs; historical aspects of athletic training. 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

587. Management of Athletic Injuries (3) S Principles of injury recognition and initial management of sports injuries for the coach, physical education teacher, and other athete health care personnel. Credit is allowed for this course or 580, but not for both. P, 377.

595. Colloquium

596. Seminar
   a. Contemporary Problems in Athletics (3) S Simko

694. Practicum
   a. Concert Production and Choreography (2 to 3) [Rpt./1] I II P, 247a-247b, 445.

795. Colloquium
   a. Physiological Adaptations to Training (2) [Rpt./1] I II P, 530.
   b. Environmental Stress and Performance (2) [Rpt./1] I II P, 530.
   c. Cardiovascular Dynamics (2) [Rpt./1] I II P, 530.
   d. Exercise Metabolism (2) [Rpt./1] I II P, 530.

PHYSICS


Associate Professors Ke-Chiang Hsieh, Adrian N. Patrascioiu, Jay E. Treat, 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.

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 the summer session) 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, 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 Ph.Ed. 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. 253.
254 DEPARTMENTS AND COURSES OF INSTRUCTION

415a-415b. Electricity and Magnetism (3-3) GC Electromagnetic phenomena; Maxwell’s equations. P, 410 or Math. 422a.

420. Optics (3) GC I 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 I 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)

433. 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 phy.s.

435. Introductory Quantum Theory and Atomic Spectra (3) GC I II Introductory quantum mechanics; solutions of the Schrödinger equation for hydrogen-like atoms; perturbation theory; atomic structure; spectra of one and many electron systems; Zeeman-Paschen-Bach effects; hyperfine structure. P, 230, 410, Math. 253; CR 470a or Math. 413 recommended.

436. Applications of Introductory Quantum Theory (3) GC II Applications of quantum theory to molecules, atomic nuclei, elementary particles and simple solids. P, 435.

440a-440b. 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, 230. (Identical with Opti. 440a-440b)


460. 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, 230.

470a-470b. 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. 253, CR 415a-415b.

504. Introduction to Quantum Optics (3) II (Identical with Opti. 504)

511. Analytical Mechanics (3) I Laws of motion as developed by Newton, d’Alembert, Lagrange and Hamilton; dynamics of particles and rigid bodies. P, 410.


525. Advanced Thermodynamics and Kinetic Theory (3) II 1983-84 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.

528. 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.

530. 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)

535. Advanced Atomic Physics (3) II 1984-85 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.

543. Laser Physics (3) I 1984-85 (Identical with Opti. 543)


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


556a-556b. Electrodynamics of Conducting Fluids and Plasmas (3-3) 1984-85 (Identical with Pty.S. 556a-556b)

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 1984-85 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) 1983-84 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) 1984-85 Continuous groups; scattering theory; relativistic wave equations; quantum electrodynamics, Feynman diagrams, dispersion theory, renormalization; strong and weak interactions. P. 515b, 570b.

580a-580b. **Quantum Field Theory** (3-3) 1984-85 Meaning of quantized fields; symmetry principles, free fields; general properties of interactions and peculiarities of electrodynamics and gravity. P. 570b, 577a.

581. **Elementary Particle Physics** (3) II 1983-84 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 Nu.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 1984-85 (Identical with Opti. 643)

685. **Graduate Physics Laboratory** (3) [Rpt./2] II Introduction to modern research methods and experiments. Problems in low-temperature physics; solid-state, atomic, and nuclear spectroscopy; computer-based data acquisition and analysis; solar-energy physics; and others.

695. **Colloquium**

**PHYSIOLOGY**

*(College of Medicine)*

Associate Professors Eidon J. Braun, Andrew M. Goldner
Assistant Professors Ziaul Haasan, Daniel R. Keshshalo, Jr. (Adjunct), Richard J. Lemen (Pediatrics), Richard L. Stouffer, 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, and membrane transport processes in 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, mathematics through calculus, a course in statistics, a course in organic chemistry, and an introductory course in biology or zoology. In addition, physical chem-
istry 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, 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 I 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. (Identical with Tox. 480)

481. Physiology Laboratory (1) GC I 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. (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) I 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 only. 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.

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) Phase II (Identical with Anat. 605)

606. Readings in Neuroscience (2) II Essentials of mammalian neural structure and function. Open to majors and minors only.

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./1] II Open to majors only. P, 600, 601, 602; 606 or Anat. 605.
PLANE TARY SCIENCES

Professors Victor R. Baker, Michael J. Drake, William B. Hubbard, Donald M. Hunten, J. Randolph Jokipii, John S. Lewis, George H. Rieke, Bradford A. Smith, Charles P. Sonett, Robert G. Strom
Associate Professors Laurel L. Wilkening, Head, William V. Boynton, Uwe Fink, Eugene H. Levy, H. Jay Melosh
Participating Faculty from the Lunar and Planetary Laboratory:
Professors Tom Gehrels, Elizabeth Roemer
Research Associate Professors Harold P. Larson, Martin G. Tomasko, Benjamin H. Zellner

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 PtyS. 403 and nine additional units in 500- or 600-level courses in the department. There is no preliminary examination in the minor. A "B" average must be achieved in the minor.

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 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 — 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. In addition, the Multiple Mirror Telescope, which is a joint project of the University of Arizona and the Smithsonian Astrophysical Observatory, has recently begun operation. Laboratory facilities for cosmochemistry include a scanning electron microscope and
microprobe, a nuclear particle track laboratory, and a radiochemistry separation laboratory. 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 and DECSYSTEM-10 computers. The Lunar and Planetary Laboratory maintains a number of special-purpose computers, including a PDP 11/40 which can be used interactively for such special applications as inversion of Fourier interferograms and reduction of data from various space programs, and as a remote batch terminal to the University computers.

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 permission. (Identical with Astr. 404)

419. Physics of the Earth (3) GC I (Identical with Geos. 419)


510. Principles of Cosmochemistry (3) I 1984-85 Chemical compositions of solar system objects; equilibrium and nonequilibrium chemical processes applied to planets; cosmochronology. P, 403, Chem. 480a-480b.


518. Experimental Methods of Planetary Science (3) I 1983-84 Nature and detection of radiant 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 calculus. (Identical with Atmo. 518 and Astr. 518)

520. Meteorites (3) II 1984-85 Classification; chemical, mineralogical and isotopic composition; cosmic abundances; ages; interaction with solar and cosmic radiation; relation to comets and asteroids. P, 510. (Identical with Geos. 520)

527. Advanced Geochemistry (3) I (Identical with Geos. 527)

528. Nuclear Geology (3) II 1984-85 (Identical with Geos. 528)

544. Physics of the High Atmosphere (3) II 1983-84 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)


554. Evolution of Planetary Surfaces (3) II 1984-85 The geologic processes and evolution of terrestrial planet and satellite surfaces including the Galilean and Saturnian satellites; possible origins of impacting objects; implications for the early history of the Earth. P, 311, 403. (Identical with Geos. 554)


565. Jovian Planets and Satellites (3) I 1984-85 Observational data; atmospheric structure and composition; thermal balance; mass, radius, flattening; physics of light elements at high pressures; structure of rotating planets; origin of magnetic fields. P, 403.

567. Inverse Problems in Geophysics (3) I 1984-85 (Identical with Geos. 567)

571. Constitution and Evolution of the Terrestrial Planets (3) I 1983-84 Composition and evolution of terrestrial planets; includes the Moon, asteroids, meteorites, other evolved rocky satellites; geophysical/geochronochemical techniques used to deduce histories. (Identical with Geos. 571)
PLANT PATHOLOGY

Professors Merritt R. Nelson, Head, Stanley M. Alcorn, Robert L. Gilbertson, Richard B. Hine, Michael A. McCoy, Michael E. Stanghellini
Associate Professors H. Earl Bloss, Iraj J. Misaghi

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, soilborne fungi, and environmental pollution.

Applicants should have a strong 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 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 Doctor's 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 Enth. 402, Pl.S. 402, and S.W.E. 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.

475a-475b. General Mycology (3-3) GC 1984-85 Introduction to the fungi, including their structure, function, classification, and ecological importance. 475a: Basidiomycetes and Fungi Imperfecti. 475b: Myxomycetes, Phycomycetes, and Ascomycetes. 2R, 3L, P, Pl.S. 100. 475a is not prerequisite to 475b.

516. Plant Nematology (3) II 1984-85 Introductory 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.

596. Seminar
a. Current Research (1 to 3) I II


694. Practicum
PLANT PROTECTION

Committee on Plant Protection (Graduate)

Professors Thomas C. Tucker (Soils, Water and Engineering), Chairperson, Stanley M. Alcorn (Plant Pathology), Roger L. Caldwell (Soils, Water and Engineering), Keith C. Hamilton (Plant Sciences), 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. 415; Pl.P. 402 and 451; Pl.S. 405; S.W.E. 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; Cell. 460; Ecol. 472; Ento. 425; Pl.S. 408; or S.W.E. 404.

PLANT SCIENCES


Associate Professors Paul M. Bessey, Koaru Matsuda, Hiroshi Muramoto

Assistant Professors Wallace C. Hofmann, Albert K. Huff, Chi Won Lee, Eugene A. Mielke

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 p.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, eleven units of p.s. 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.


506. Plant Resistance to Insects (2) II 1984-85 (Identical with Ento. 506)

516. Genetic Principles of Hybrid Seed Production (3) II Genetic and cytogenetic principles applied to the development and maintenance of inbreds and to the production of hybrid seed. P, 228, G.Bio. 320 or 321. Bemis

528. Plant Microtechnique (4) II 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


562. Plant Intermediary Metabolism (3) II 1984-85 (Identical with Cell. 562)

564. Plant Growth and Development (3) II 1983-84 (Identical with Cell. 564)


634. Quantitative Genetics and Selection (3) II 1983-84 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.; Agri. 539.

635. Advanced Cytogenetics (4) II 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

696. Seminar
  a. Agronomy (1) [Rpt./2] I II
  b. Horticulture (1) [Rpt./2] I II
POLITICAL SCIENCE

Professors John C. Wahlke, Head, James A. Clarke, Richard C. Cortner, Vine Deloria, Jr., Rosendo A. Gomez (Emeritus), Neal Houghton (Emeritus), Helen M. Ingram, Conrad F. Joynor, Paul Kelso (Emeritus), Clifford M. Lytle, Edward N. Muller, Jerrold G. Rusk, Currin V. Shields (Emeritus), Peter A. Toma, 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, political behavior, international relations, comparative politics, and American Indian policy studies. A terminal program for the Master of Arts degree is also available 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 eighteen units of course work (in the terminal program) or 24 units of course work (in the regular program) at the 500 and 600 levels. A supervised research paper or a thesis 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. The Legislative Process (3) GC I II Analysis of relations between Congress and other consequential forces, including the White House, lobbyists and public opinion; internal life and roles of Congress in national decision making; comparisons with state and foreign systems.

412. Local Government and Administration (3) GC I II Examination and analysis of local decision-making structures and their policy outputs. P, 103.

421. Ancient and Medieval Political Theory (3) GC I Development of Western political theory from the Greeks to Machiavelli.

422. Early Modern Political Theory (3) GC II Western political theory from Machiavelli to Marx.
Recent Political Thought (3) GC I II Political theory from Marx to the present.

American Political Thought (3) GC II American political ideas from colonial times to the present.

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.

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.

Political Research and Methodology (3) GC I Introduction to research design and methods, with attention to philosophical foundations of modern political science.

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.

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)

Personality and Politics (3) GC II Examination of the theories and concepts associated with the psychological basis of various types of political behavior.

Political Participation and Democracy (3) GC I Cross-national survey of political attitudes and behavior of ordinary citizens relevant to the stability of democratic political systems.

Politics and Mythology (3) GC I Comparative examination of the role of mythology in building nations, political legitimation, and cultural revitalization.

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.

East European Politics (3) GC II Divergent models of Communist development, from East Germany to Yugoslavia; political, economic, social and cultural reform.

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.

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.

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.

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)

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.

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.

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.

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.

American Foreign Policy (3) GC I II Analysis of the Cold War; Congressional-Executive clashes over foreign policy control; approaches to policy analysis.

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.

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.

Government and Politics of the Middle East (3) GC II (Identical with Or.S. 458, which is home.)

Problems of World Order (3) GC I 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.

Modern Chinese Foreign Relations (3) GC II (Identical with Or.S. 460)

Chinese Politics, 1911-Present (3-3) GC (Identical with Or.S. 461a-461b)

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.

472a-472b. **Philosophy of Law** (3-3) GC (Identical with Phil. 472a-472b)

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 I 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 1984-85 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. **Formation 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 formation of public policy at the national, state, and local levels.

481. **Environmental Policy** (3) GC I Role of government in management of energy, natural resources and environment; process and policy alternatives; special attention to the Southwest. (Identical with W.R.A. 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, behaviorial, and comparative perspectives. (Identical with A.In.S. 487 and BLS. 487)

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; unobtrusive 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.

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

598. **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

610a-610b. **Fiscal and Budgetary Administration of Public Agencies** (3-3) (Identical with P.P.P.A. 610a-610b)
PSYCHOLOGY


Associate Professors Harold S. Arkowitz, Philip Balch, Wayne R. Carroll, Lewis Hertz, Spencer A. McWilliams, Ronald H. Pool, William H. Thweatt

Assistant Professors Jeff L. Greenberg, David E. Kieras, George P. Knight, Karen A. Paulsen, Susan A. Warner

Lecturers Hubert R. Estes, Reed A. Mencke

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 neurological 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 (developmental psychology, adolescent behavior, aging processes, personality, and psychopathology). 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 psychology 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 competence 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 laboratory techniques, research literature, and anatomical and physiological knowledge with behavioral theory. P, 100a-100b, 255, 302.

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, 100a-100b; and 302 or 8 units of bio. lab. sci.

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, 100a-100b, 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, 100a-100b.

411aL-411bL. Comparative Psychology Laboratory (1-1) GC 411aL: Lab. training in animal early experience and social behavior research. P, 100a-100b, 245, CR 411aR. 411bL: Lab. training in animal learning techniques. P, 100a-100b, 245, CR 411bR. 411aL is not prerequisite to 411bL.

414R. Advanced Developmental Psychology (3) GC I II Research and theory in the development of individuals from birth to death. P, 100a-100b, 313.

414L. Advanced Developmental Psychology Laboratory (1) [Rpt./1] GC I II Applications of developmental psychology in lab. and natural settings. P, 100a-100b; 414R or CR.

416. Personality (3) GC I II Advanced study of theories of personality; methods and results of personality study. P, 100a-100b, 245.

418. Abnormal Psychology (3) GC I II Nature and etiology of various forms of behavior disorder, mental deficiency, and other deviations; critical evaluation of current theories. P, 100a-100b, 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, 100a-100b.

425. Advanced Perception (3) GC II Experiments in perception and sensory processes. P, 100a-100b, 255, 329; or grad. standing.

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.Art. 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, 100a-100b. 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, 100a-100b or grad. standing.

450. Psychological Assessment and Testing (3) GC I II Evaluation of assessment processes and of measurements of intelligence, aptitudes, personality, and interests; test theory; social implications. P, 100a-100b, 245.

455. 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, 100a-100b, 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, 100a-100b, 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, 100a-100b 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, 100a-100b and six units upper-div. psych.; or grad. standing.

483. Topics in Social Bases of Behavior (3) [Rpt./1] GC I II Variable content (consult schedule); group processes, organizational theory, leadership, others. P, 100a-100b and six units upper-div. psych.; or grad. standing.

484. Topics in Individual Bases of Behavior (3) [Rpt./1] GC I II Variable content (consult schedule); developmental psychology, personality, psychopathology, others. P, 100a-100b and six units upper-div. psych.; or grad. standing.

485. Contemporary Issues in Psychology (3) [Rpt./1] GC I II Variable content (consult schedule); major topical problems in psychological research, theory, and applications. P, 100a-100b and six units of upper-div. psych.; 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 1984-85 Theories and research in the development of social behavior patterns and personality.

552. Child Language Development (3) II 1983-84 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) 1984-85 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] 1983-84 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.

576. Contemporary Issues in Experimental Psychology (3) [Rpt./1] I II Advanced study of topical problem areas in general and experimental psyc.


596. Seminar
u. Interdisciplinary Environment-Behavior-Design (3) [Rpt./1] I (Identical with Ids. 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. Scientific and Professional Aspects of Clinical Psychology (3) I Orientation to clinical psychology; relationship of community and socioeconomic conditions to emotional disturbance; ethical considerations in research and practice. 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] I II Open to clinical psyс. students only.
   b. Psychotherapy (1 to 3) [Rpt./1] I II Open to clinical psyс. students only.
   c. Community Mental Health (1 to 3) [Rpt./1] I II Open to clinical psyс. students only.

   PUBLIC ADMINISTRATION
   (See Public Policy, Planning and Administration)

PUBLIC POLICY, PLANNING AND ADMINISTRATION

Professors Don L. Bowen, Robert D. Carpenter, Lawrence D. Mann, June M. Morrison, Raymond A. Mulligan, Arthur L. Silvers, Norman Williams, Jr.
Associate Professors Michael K. Block, Robert W. Buckingham, Jon B. Christianson, Theodore H. Koff, Ronald J. Vogel
Assistant Professors Eric W. Carlson, Reid H. Ewing, Vernon L. Greene, Richard B. Polley

The Department of Public Policy, Planning and Administration is being reorganized. For information contact the head of the Department of Management.

The department offers programs leading to the Master of Public Administration degree. Concentrations are available in public management, health services administration, human services administration, and criminal justice administration.

For information concerning the requirements for this degree see Requirements for Master's Degrees/Master of Public Administration elsewhere in this catalog.

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)

413. Administrative Leadership (3) GC I Elements of leadership, as applied to selected administrative situations in the field of public management.

414. Project Management (3) GC I Organizational, environmental, and analytical aspects of project planning and management, including government contracting and grants, as applied to public sector projects.

415. Public Personnel Policies (3) GC II Description and analysis of operation of public personnel systems.

417. Public Sector Labor Relations (3) GC II Description and analysis of recent developments in public employee labor relations at federal, state, and local levels.

444. Group-Process Methods in Public Administration (3) GC II 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)

445. Human Relation Skills in Administration (3) GC II Psychological techniques applied to the improvement of leadership and other organizational skills in public management.

463. Program Planning for Human Services (3) GC II Deals with the process of program planning from problem identification and need assessment through implementation and evaluation, with specific application to human services administration.

588. Operations Research in Health Care Delivery (3) II (Identical with S.I.E. 588)

595. Colloquium
   a. Public Management (3) [Rpt./12 units] I II
   b. Urban Affairs (3) [Rpt./12 units] I II
   c. Health Care (3) [Rpt./12 units] I II
d. Aging and Society (3) [Rpt./12 units] I II
e. Corrections (3) [Rpt./12 units] I II
   f. Criminal Justice (3) [Rpt./12 units] I II

600. Advanced Public Administration (3) I Fundamentals of structure and process in public administration, with respect to both its academic study and applications.
Analytic Methods in Planning and Management (3) II (Identical with U.P. 604)

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, 600, Mgmt. 552.

Fiscal and Budgetary Administration of Public Agencies (3-3) 610a: Internal fiscal operation and the budgetary cycle of public and nonprofit agencies. P, 600, Acct. 572. 610b: Cost/benefit analysis for public agencies. 610a is not prerequisite to 610b. (Identical with Pol. 610a-610b)

Administrative Patterns in the Federal System (3) I Legal, political, and social framework of inter-jurisdictional and interagency relations; trends, emerging issues, and devices for securing coordination and responsibility.

Public Policy and Police Administration (3) II Research-based critique of contemporary police administration in relation to its success in meeting the goals of public policy on crime control and community order maintenance. P, 600, 605.

Public Policy and Correctional Administration (3) I Research-based critique of contemporary correctional administration in relation to its success in meeting the goals of public policy on the correction of criminal offenders. P, 600, 605.

Advanced 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.

Health and Public Policy (3) II Examines public policy issues in health, including recent developments in health policy and planning at the national, state and local levels, and their impact on administrative behavior. P, 650.

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.

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.

Aging and Public Policy (3) I Policy framework for administration of programs, plans, priorities, and legislation related to the needs of the aging in modern society.

Internship
a. Law Enforcement Administration (1 to 6) I II
b. Correctional Administration (1 to 6) I II
c. Public Management (1 to 6) I II
d. Health Services Administration (1 to 6) I II
e. Public Recreation Administration (1 to 6) I II
f. Retirement Housing Administration (1 to 6) I II

Seminar
a. Development Administration (1 to 3) [Rpt./6 units] I II
b. Program Planning and Development (1 to 3) [Rpt./6 units] I II
c. Performance Measurement and Accountability (1 to 3) [Rpt./6 units] I II
d. Comparative Law Enforcement Systems (1 to 3) [Rpt./6 units] I II
e. Health Services Administration (1 to 3) [Rpt./6 units] I II
f. Environmental Administration (1 to 3) [Rpt./6 units] I II
g. Criminal Justice Administration (1 to 3) [Rpt./6 units] I II

RANGE MANAGEMENT
(See Renewable Natural Resources)
READING

Professors William J. Valmont, Head, Wilbur S. Ames, Elizabeth M. Antley, Amelia Melnik, Kenneth J. Smith
Associate Professors Adela A. Allen, Patricia L. Anders, John M. Bradley, Judy N. Mitchell
Assistant Professor Stephanie L. Brown

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. 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. For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

406. 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)

435. 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)

480. Literature for Children (3) GC I II (Identical with L.I.S. 480)

485. Literature for Adolescents (3) GC I II (Identical with L.I.S. 485)

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

506. Bilingual Reading (3) I 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)

520. Reading in the Content Areas (3) II Advanced examination of activities to integrate process and content instruction at all grade levels, with emphasis on interaction between classroom teachers and reading specialists.

561. History of Children's Literature (3) II (Identical with L.I.S. 561)

571. 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.

594. Practicum
   a. Reading for the Exceptional Child (3) I II P, 304, 406, 435, or 607.

602. 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.

605. Essentials of Reading Instruction (3) I II Theories and principles underlying reading instruction, approaches to teaching reading, basic analysis of reading research.

607. 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.

612. 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.

628. **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.

633. **Psycholinguistics and Reading** (3) I II Basics in psycholinguistics of reading and reading instruction, with emphasis on the comprehension of written language.

637. **Application of Misuse Analysis** (3) II 1983-84 (Identical with Elem. 637)

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 [Rpt./15 units]

795. **Colloquium**
   - a. Problems in Reading (1 to 3) I II

796. **Seminar**
   - a. Research and Evaluation (1 to 3) I II

**REAL ESTATE**
*(See Finance and Real Estate)*

**REHABILITATION**

Professors Amos Sales, **Head**, Bob G. Johnson
Associate Professor S. Mae Smith
Clinical Associate Professors Marlene Bence, Inez Tucker
Clinical Assistant Professors William Downey, James Organist
Lecturer Thomas L. Fisher

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, November 1 for spring 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. Specific requirements for doctoral programs may be obtained by writing to the department.

405. **Fundamental Sign Language** (3) GC I II Fundamentals of sign language to develop communication skills for providers of social services for the deaf.


420. **Advanced Conversational Sign Language** (3) GC I II Comprehensive study of basic sign language idioms and colloquialisms in Amesian, with emphasis on continued skill building, expressive and receptive ability in Amesian, and ability to converse with deaf adults. P, 410 or demonstrated proficiency.

425. **Advanced Amesian** (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.

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 I II Emphasis on aging from the viewpoint of the aging person and those working with the aged.

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.

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

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. **Plan Development in Rehabilitation** (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.

COLLOQUIUM

a. Rehabilitation Psychology (3) I II
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

INVESTIGATIONS IN REHABILITATION PSYCHOLOGY (3) II Identification and analysis of current problems in rehabilitation.

RELIABILITY ENGINEERING

*(See Engineering)*

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), Richard W. Reeves (Geography and Regional Development)

Associate Professor Charles E. Glass (Mining and Geological Engineering)

Assistant Professors Charles F. Hutchinson (Arid Lands Resource Sciences), William O. Rasmussen (Renewable Natural Resources), Robert A. Schowengerdt (Electrical and Computer Engineering and Arid Lands Resource Sciences)

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, Earth Sciences, 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.
RENEWABLE NATURAL RESOURCES

(College of Agriculture)


Assistant Professors Robert L. Gillen, Susan J. Hebel, R. William Mannan, William J. Matter

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, arid land 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 fifteen units of course work and an additional fifteen units of research, devoting one year to each of the two requirements, for the master's degree. The research work must be concerned with a field problem and result in the writing of an acceptable thesis.
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 with 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

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 1984-85
   b. Public Natural Resource Management (2) II
   c. Human Dimensions in Renewable Natural Resources (2) I 1983-84
   d. Topics in Forest and Range Ecology (2) II 1983-84

Landscape Resources

Stanley K. Brickler, Chairperson of the Division

Landscape Architecture

420a-420b. Landscape Analysis, Planning and Design (5-5) GC 420a: Omnibus studio; problem solving in rural and urban environments. 420b: Regional problems. 2R, 9L. Field trips. P. 101, 112b.


424a-424b-424c. Advanced Land Planning and Design (1-5-5) GC 424a: I Orientation and proposal development for omnibus project. 424b: I Special studies studio; Individual emphasis. 424c: II Complex problems in regional and urban environments. Field trips. P, CR 422b or nine units arch. or u.pl.

426. Field Methods in Environmental Psychology (3) GC II (Identical with Psyc. 426)

435. Planting Design (3) GC II Application of plant materials to problems in landscape design. 2R, 3L. Field trips. P. 420b, 334b.

441. History and Theory of Landscape Architecture (3) GC II Examination of the historical background and theoretical basis of landscape architecture. P. 420a.

451. Site Engineering (3) GC II Introduction to topography, contours, grading, drainage, road layout, utilities, and other site engineering considerations. 2R, 3L. Field trips. P. 420a, 350.

452. Landscape Construction (3) GC I Construction materials and methods in landscape architecture; introduction to working drawings and specifications. 2R, 3L. P. 420b, 451.

453. Contract Documents and Professional Practice (2) GC II 1983-84 Techniques and procedures for preparation of working drawings and specifications, and for professional office conduct. P. 420b, 452.

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 Ids. 596u, which is home)
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. 6L. All-day field trips. P, CR 456; 486.

595. Colloquium
   a. Rangeland Policy (2) I 1984-85
   c. Range Herbivores (2) I 1983-84

696. Seminar
   a. Range Management (1) [Rpt.] I II

Forest-Watershed Resources

Gordon S. Lehman, Chairperson of the Division

Watershed Management

406. 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. Zwiklinski

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. Wagley


420. Photogrammetry (2) GC I Aerial photographic planning for natural resource management; stereoscopic principles applied to planimetric and topographic mapping. 1R, 3L. P, Math. 118. Knorr

422. Photointerpretation (2) GC II Reading and interpretation of aerial photographs; natural resource inventory from aerial photographs; remote sensing techniques. 1R, 3L. Lehman

425R. Forest Products (2) GC II 1984-85 Harvesting, processing, and marketing of wood products. P, G.Bio. 104 or Pl.S. 100. Foliott

425L. Wood Technology Laboratory (1) GC II 1984-85 Macroidentification of commercially important woods.

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. Knorr
**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**

**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.E. 201.**

**Watershed Hydrology (3) GC I Application of fundamental principles to quantifying the basic hydrologic processes occurring on watersheds. P, Geos. 100a or 151; S.W.E. 200, 201, Math. 160. (Identical with Hydr. 460)**

**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)**

**Water Quality Control (3) GC II (Identical with C.E. 471)**

**Natural Resource Economics (3) GC II (Identical with A.Ec. 476)**

**Forest Policy and Administration (3) GC II Evolution of natural resource policy in the U.S.; resource policy formation; analysis of present policy and trends; legal and administrative aspects of natural resource use. P, 440 or N.R.R. 470 or A.Ec. 215 or 476. (Identical with A.Ec. 480, Ra.M. 480 and W.R.A. 480) King**

**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.**

**Forestry in Arid Environments (3) GC S Management and development of woody and other forest resources in developing nations. Designed for mid-level and upper-level resource professionals from developing nations. Field trip.**

**Development and Management of Water Resources (4) 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.**

**Snow Hydrology (2) I 1984-85 Physical properties of snow, melt and runoff characteristics, measurements, flood and water yield prediction, forest-snow relationship and management potential. P, 460 or C.E. 423. (Identical with Hydr. 502) Gay**

**Modeling of Small Watershed Hydrology (3) II Techniques for synthesizing the hydrologic behavior of watershed catchments. P, 460, 462.**

**Systems Analysis in Watershed Management (3) II 1984-85 Application of hydrologic modeling and system analysis for optimizing management of watersheds. P, 460, 462.**

**Quantitative Methods in Dendrochronology (3) I 1984-85 (Identical with Geos. 557)**

**Plant-Water Relations (3) II (Identical with Cell. 563)**

**Hydrochemistry (3) II 1983-84 (Identical with S.W.E. 565)**

**Botanical Basis of Dendrochronology (3) II 1983-84 (Identical with Geos. 566)**

576a-576b. **Advanced Natural Resource Economics (3-3) (Identical with A.Ec. 576a-576b)**

**Colloquium**

  a. Non-Point Source Pollution from Watersheds (3) II P, 460.
  b. Arid Land Forestry (2) II 1984-85
  c. Urban Forestry (2) II 1983-84
  d. Fire Ecology (2) II

**Dendroclimatology (4) II 1984-85 (Identical with Geos. 655)**

**Seminar**

  a. Watershed Management (1) [Rpt.] I II

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**Wildlife, Fisheries and Recreation Resources**

**William W. Shaw, Chairperson of the Division**

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**Wildlife and Fisheries Science**

401. **Aquatic Entomology (3) GC II 1984-85 (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 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, G.Bio. 104; Ecol. 102 or Ra.M. 416. Krausman

448. 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, 444.

555L. Fishery Management Laboratory (1) GC II Laboratory methods pertaining to fishery investigations and management. P, CR 455R, 482. Matter

452. Ichthyology (4) GC I (Identical with Ecol. 482)

454. Ornithology (4) GC II (Identical with Ecol. 484)

455. Mammalogy (4) GC I (Identical with Ecol. 485)

537. Advanced Ecology (2) II (Identical with Ecol. 537)

547. Ecology of Wildlife Reproduction (2) II Mechanisms by which environmental factors influence reproductive success in wildlife populations. P, Ecol. 102, V.Sc. 400b or Ecol. 467R. (Identical with Ecol. 547) N. Smith

584. Selected Studies of Birds (2) I II (Identical with Ecol. 584)

595. Colloquium
   a. Big Game Management (2) I 1984-85 P, 444.

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

698. Seminar (1 to 3) I
   a. Fish and Wildlife Ecology (1) [Rpt.]

Natural Resource Recreation


470. Economics of Outdoor Recreation (3) GC II 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. Leisure Theories and Recreational Behavior (2) GC II Theories of leisure behavior and their implications for management of natural resources for outdoor recreation. P, 381, 388.

595. Colloquium

ROMANCE LANGUAGES
(See French and Italian
or Spanish and Portuguese)
RUSSIAN AND SLAVIC LANGUAGES

Professor Joe Malik, Jr., Head
Associate Professors Alexander Dunkel, Boriss Roberts
Assistant Professors Adele Barker, Margaret Gibson, Roger Hagglund, Delbert Phillips

The department offers a program leading to the 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 and 583. All graduate teaching assistants must take 579. With the permission of the head of the department, the remaining units may 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.

581. Russian Phonology and Morphology (3) I 1983-84 P, 301b.


685. Old Church Slavic (3) II

686. Russian Drama (3) I 1984-85 Examination of the major dramatic works of nineteenth- and twentieth-century playwrights such as Gogol, Turgenev, Ostrovsky, Chekhov, Gorky and others of the Soviet period. P, 405b.

696. Seminar
a. Slavic Philology (3) I II
d. Russian Literature: 20th Century (3) I II
b. Russian Literature: 18th Century (3) I II
e. West Slavic Literature (3) I II
c. Russian Literature: 19th Century (3) I II

SCHOOL LIBRARY SCIENCE
(See Library Science)
SECONDARY EDUCATION

Associate Professors Margaret B. Fleming, Bruce R. Ledford, Glenn S. Pate, James R. Rankin
Assistant Professors George Babich, D. Paul Robinson, Janice L. Streitmatter
Lecturer Edward J. Van Metre

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 modified or waived for applicants in educational media or for the Master of Teaching degree who have other appropriate backgrounds. Applicants for specialist or doctoral 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 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. For further information concerning these degrees see Requirements for Graduate Degrees elsewhere in this catalog.

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 I II Specific methods, objectives, organization of subject matter and evaluation in modern languages. (Identical with Fren. 414 and Span. 414)
417. Visual and Auditory Aids in Teaching (3) GC I II Operation of AV equipment; preparation of various teaching aids. (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 Rdgng. 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.
449. Techniques of Teaching Adults (3) GC I II Techniques and issues of adult learning and the dynamics of the teaching and learning processes.
482. Teaching Vocational Office and Distributive Education (3) GC II (Identical with B.C.Ed. 482)
483. Development and Instruction of Adult Vocational Education Programs (3) GC I (Identical with B.C.Ed. 483)
484. Organization and Supervision of Vocational Education Programs (3) GC I (Identical with B.C.Ed. 484)
485. **Cooperative Vocational Education Programs** (3) GC II (Identical with B.C.Ed. 485)

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

526. **Methods and Materials in Bilingual Education** (3) I II (Identical with Elem. 526)

531. **Career Education** (3) I (Identical with Coun. 531)

532. **The Middle School/Junior High** (3) II History, purposes, curriculum, and administration of the middle school/junior high.

545. **Multicultural Instructional Materials Development** (2 to 4) S Study tours to various regions and countries to produce audiovisual instructional materials. (Identical with Elem. 545)

567. **Law for Teachers and Student Personnel Workers** (3) II (Identical with Ed.F.A. 567)

595. **Colloquium**
   c. Language Experiences in Learning (3) II S (Identical with Elem. 595c, which is home.)

597. **Workshop**
   b. Educational Film and Video in the Classroom (3) I
   f. Investigating the Environment (1 to 3) I II S (Identical with Elem. 597f)
   o. The 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 (3-9) [Rpt./12 units] I II S (Identical with Elem. 597w and Engl. 597w)

612. **English Grammar for ESL** (3) I (Identical with Engl. 612)

613. **Teaching of ESL** (3) I (Identical with Engl. 613)

616. **Coordination of Instructional Media Programs** (3) II 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 L.S. 616)

617. **Preparation of Instructional Materials** (3) II Study of techniques used in the development of instructional materials and processes. P. 417. (Identical with Elem. 617 and L.S. 617)

631. **Curricular Studies in School Mathematics** (3) II 1984-85 Experimental programs in school mathematics, with emphasis on selection of content and on problems in design and evaluation. (Identical with Elem. 631)

633. **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.

634. **Analysis of Secondary School Teaching** (3) I II 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 II 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 II 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, 639.
   f. Secondary School Evaluation (1 to 3) I II P, 635.
   g. Master's Colloquium in Secondary Education (1 to 3) I II
SOCIOMETRY

Professors Richard F. Curtis, Head, Raymond V. Bowers (Emeritus), Beverly Duncan, Otis Dudley Duncan, Maynard L. Erickson, Andrew M. Greeley, Robert L. Hamblin, Donald S. Klaiss (Emeritus), Robert C. Leonard, Stanley Lieberson, Arthur Stinchcombe, I. Roger Yoshino

Associate Professors Albert J. Bergesen, James T. Borhek, Courtney B. Cieland, Robert R. Evans, Celestino Fernández, Michael Hout, Gary F. Jensen, Jerry L. L. Miller

Assistant Professors Neil D. Fligstein, Joseph R. Hambenne (Emeritus), Carol Heimer, Douglas McAdam, Patricia L. MacCorquodale, Michael 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 March 1 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: 570a-570b, 575; two offerings from 500a-500b-500c; 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. Students who perform at a high level on a screening exam will be excused from the statistics requirement. In addition, students will be expected to complete any two of the following courses: 510, 525, 530, 541, 550, or 589. Written preliminary examinations must be completed in two major areas and one minor area (culture, deviance and control, mathematical sociology, population and ecology, social interaction and socialization, social organization, and social structure). If the minor is taken within the Department of Sociology, then the student must write preliminary examinations in three of these areas. There is an oral preliminary examination which 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. Group Structure and Personality (3) GC II Relation between the person and the group; social factors in character formation. P, nine units of soc. Evans

444. Group-Process Methods in Public Administration (3) GC II (Identical with P.P.P.A. 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 substitute 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, Bl.S. 461 and M.A.S. 461) Lieberson

486. 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)

500a-500b-500c. Sociological Theory (3-3-3) Major issues in theoretical sociology. 2R, 3L. P, 401; one course in calc. (for 500b).

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.

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) Statistical analysis of sociological data. 2R, 3L, P, 375b.


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.

589. Advanced Demography (3) Basic study of recent developments in demographic research on population trends. Lieberson

596. Seminar
a. Advanced Problems in Research (1 to 3) [Rpt.] I II
b. Advanced Problems in Deviant Behavior (1 to 3) I II
c. Selected Problems in Sociological Statistics (1 to 3) I II
d. Advanced Social Change (1 to 3) [Rpt.] I II
e. Advanced Juvenile Delinquency (1 to 3) I II
f. Macrosociology (1 to 3) I II

SOIL AND WATER SCIENCE
(See Soils, Water, and Engineering)

SOILS, WATER, AND ENGINEERING


Associate Professors Moody D. Cannon, Wayne E. Coates, David M. Hendricks, Dennis L. Larson, Ian L. Pepper

Assistant Professor Allan D. Matthias

The department offers programs leading to the Master of Science degree with majors in agricultural engineering or in soil and water science. The department also offers a program leading to the Doctor of Philosophy degree 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. 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, 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 PLP. 402)

404. Irrigation Principles and Practices (3) GC II Principles of irrigation, irrigation water supply, conveyance and measurement of water, water requirements, surveys applications in irrigation and evaluation of irrigation systems. 2R, 3L. Field trip. P, 200, Math. 117e. Fangmeier

405. Hydrology of Unsaturated Media (3) GC I (Identical with Hydr. 405)

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, Math. 117e, 118, Phys. 102a.
410. **Farm Power Engineering** (3) GC I 1983-84 Principles of operation, design and performance of tractors, engines, electric and hydraulic motors for agricultural environments. 2R, 3L. P. A.M.E. 232, 340a. **Hundt**

411. **Soil Chemistry** (3) GC I Soil chemical interactions with water, air, plants and pollutants. P, 200, Chem. 103b, 104b. **Bohn**


422. **Irrigation Engineering** (3) GC II Design and operation of irrigation and drainage systems for agricultural lands, surface, sprinkler and trickle systems, wells, water measurement and Irrigation scheduling. 2R, 3L. P, CR 406 or C.E. 321. (Identical with C.E. 422) **Fangmeier**

423. **Agricultural Systems** (3) GC I 1984-85 Application of systems analysis to agricultural problems; modeling and use of operations research methods. P, S.I.E. 270. **Larson**

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**

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 or 151. **Post**

435. **Soil Microbiology** (3) GC I Nature of soil microorganisms and their transformations of inorganic and organic soil constituents, growth-controlling substances, and impact on general environmental quality. 2R, 3L. P, Chem. 241a, G.Bio. 101b. (Identical with Micr. 435) **Pepper**

461. **Soil and Water Conservation** (3) GC II 1984-85 Consideration of major world soil and water conservation problems and solutions; principles of soil erosion by wind and water and their effects on world food problems. 2R, 3L. Field trips. P, 200. **Post**

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 Nu.E. 453) **Larson**

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. **Warrick**

497. **Workshop**

c. Irrigation (1 to 2) GC I II

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 Analyses of Soils and Plants** (4) II Principles and methods of chemical analyses of soils, water and biological materials with emphasis on instrumental techniques. 2R, 6L. P, Chem. 322, 323; Phys. 102b, 180b. **Hendricks**

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 470. (Identical with C.E. 507)

514. **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 1983-84 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] I II


605. **Soil-Water Dynamics** (3) II 1984-85 Water flow in soils; closely related problems of solute, pollutant, and heat transfer; emphasis on current concepts and research. P, Math. 253 or 254. (Identical with Hydr. 605) **Warrick**
286 DEPARTMENTS AND COURSES OF INSTRUCTION

611. Advanced Soil Chemistry (3) 1984-85 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] I II Wiersma

SOUTHWEST STUDIES

Southwest Center

Director: Michael C. Meyer
Assistant Director: Mardith Schuetz

Southwest studies are designed to bring new perspectives to regional subjects through an interdisciplinary approach.

456. Southwest Studies I (3) GC Environment of the Southwest and northern Mexico. Man’s advent into the region from pre-contact times through Spanish, Mexican and U.S. expansion. (Identical with A.In.S. 456, La.S. 456, and M.A.S. 456)

457. Southwest Studies II (3) GC Artistic, literary and musical expressions of the Southwest and northern Mexico; native American, Hispanic, and Anglo contributions to the present time. (Identical with A.In.S. 457, La.S. 457, and M.A.S. 457)

SPANISH AND PORTUGUESE

Professors Rupert C. Allen, Leo L. Barrow, A. Dolores Brown, Jack Emory Davis (Emeritus), Juan J. Gilabert, Lanin A. Gyurko, Herman Iventsch, 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, Head, Karl C. Gregg, H. Reynolds Stone
Assistant Professor Armando Miguélez
Lecturers Adalberto Guerrero, M. Nieve Pereira Parsons

The department offers programs leading to the Master of Arts degree with majors in Spanish and Romance languages, and the Doctor of Philosophy degree 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.

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.

MASTER OF ARTS (Major in Romance languages) — 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).

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.

* Details of specific departmental requirements for the various degree programs should be obtained from the Director of Graduate Studies of the Department of Spanish and Portuguese.

Spanish

400a–400b. Survey of Spanish Literature (3-3) GC 400a: From the beginning through the 17th century. 400b: 18th-20th centuries. 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. 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 1984-85 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.

435. Cervantes and His Works (3) GC II


443. Mexican-American Literature (3) GC II Study of the literature, in Span. and Engl., created by the Mexican-American in the United States. (Identical with L.I.S. 443 and M.A.S. 443)
445. Novel of the Mexican Revolution (3) GC I

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. (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)

510. Bibliography (3) II 1963-84 Bibliographical methods and principal bibliographies.

511. Literary Theory and Criticism (3) II 1984-85 Historical survey of theoretical writings on literature, with their implications for practical criticism.

540. Introduction to Medieval Literature (3) I 1984-85 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 1983-84 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 1984-85

551. Spanish American Lyric Poetry from the 1830s through the 1920s (3) II 1984-85

552. Spanish American Lyric Poetry from the 1830’s to the Present (3) I 1983-84


554. Spanish American Narrative from the 1830’s through the 1920’s (3) II 1983-84 Novel, short story, narrative poetry, and the artículo de costumbres.


556. Spanish American Theatre (3) II 1983-84 Major dramatic works from Colonial times to the present.

557. Spanish American Essay (3) II 1984-85 Major essays from Independence to the present.

560. Golden Age Prose (3) II 1984-85 The Celestina, chivalric, picaresque, and pastoral novel from the late 15th through the 17th century.

561. Golden Age Poetry (3) II 1983-84 The major poets from the early 16th through the 17th century.

562. Golden Age Theatre (3) I 1983-84 The major dramatists from the early 16th through the 17th century.

563. Neoclassicism and Romanticism (3) I 1984-85 The emergence of Spanish Romanticism from the Enlightenment.

564. Realism and Naturalism (3) II 1984-85 Major prose writers of the 19th century from Galdós to Blasco Ibáñez.

565. The Generation of ’86 (3) I 1983-84 Major literary expressions concerning the problems of Spain and the Spaniard from the late 19th century to 1936.

566. Contemporary Spanish Novel (3) I 1984-85 The novel since the Civil War.

567. Poetry and Drama since the Civil War (3) II 1983-84

620. History of the Spanish Language (3) I 1983-84

621. Spanish in the Americas (3) I 1984-85

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 1984-85 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 1984-85 (Identical with Span. 422)

463. Studies in Brazilian Literature (3) GC I 1983-84 Major works, authors and tendencies in modern Brazilian literature. P. 201b or 202b.

464. Studies in Portuguese Literature (3) GC II 1983-84 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

Romance Languages

422. Introduction to Romance Philology (3) GC I 1984-85 (Identical with Span. 422)

429. Pedagogical Linguistics: Applied Linguistics for Language Teachers (3) GC II (Identical with Or.S. 429)

SPECIAL EDUCATION

Professors Jeanne McRae McCarthy, Head, Sidney W. Bijou, James C. Chalfant, William C. Healey, Samuel A. Kirk
Assistant Professors Shirin Antia, Candace Bos, C. June Maker, Maria Nahmias, Ivan S. Tetzlaff, John Umbreit, 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 behavior disorders, 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.

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.

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. P. 403.

408. Diagnosis and Remediation of Learning Problems (3) GC I II Educational and psychological assessment of children with learning problems; development of competencies required to teach such children. P. 403 or CR. Not open to students in the learning disabilities concentration.
410. **Vision and Visual Functioning** (3) GC 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.

419. **Behavior Principles for the Handicapped Child** (3) GC I II Use of behavior principles of learning to alter behavior of handicapped children, especially moderately and severely handicapped. 3R, 1L, P, 403.

423. **The Special Education Teacher** (3) GC I I I S Information to aid teachers in dealing with responsibilities and concerns in school settings with regard to P.L. 94-142, Education for All Handicapped Children Act.

427. **Bilingual/Bicultural Education Curriculum Development** (3) GC II (Identical with Ed.F.A. 427)

456. **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; etiology, classification, and characteristics of the retarded, with consideration of their educational, social, and interpersonal problems. P, 403 or CR.

472. **Physically Handicapped Child** (3) GC I Characteristics, etiology, and educational implications of physical handicaps and special health problems. P, 403.

473. **Education of Children with Behavioral Disorders** (3) GC I Educational programs for children who are emotionally disturbed or socially maladjusted. P, 403.

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

495. **Colloquium**
   c. Special Education (1) GC I II Open to majors only.
   g. Introduction to Early Childhood Education for the Handicapped (1) GC I P, 403.

497. **Workshop**
   c. Illinois Test of Psycholinguistic Abilities (2) GC I II
   g. Teacher-Parent Relationships in Special Education (3) GC I II
   j. Language Assessment for the Exceptional Child (2) GC Rpt./1] II 2R, 1L, P, 403, 581.


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 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 594.

507. **Teaching Severely Handicapped** (3) I Specific information, techniques, and methods applicable to the systematic instruction of severely and multiply handicapped children and adolescents. P, 403.

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.


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; emphasis on methods of teaching reading, writing, and mathematics.


526. **Methods and Materials in Bilingual Education** (3) I II (Identical with Elem. 526)

550. **Administration and Supervision of Special Education Programs** (3) I Practical aspects of organization and development of special education programs, problems of public relations, personnel, case finding, evaluation, placement, and records.

572. **Teaching the Physically Handicapped** (3) II Methods of teaching children who have physical handicaps or special health problems.

573. **Teaching Children with Behavioral Disorders** (3) II Various methods and techniques for teaching the emotionally disturbed. P, 473.
574. **Curriculum Adaptations for Exceptional Children** (3) I II Strategies for developing, adapting, and evaluating curricula for exceptional children. Emphasis on individualization and application of strategies. P. 403.

575. **Observation and Participation in Special Education Programs** (1 to 3) I II Specific types of exceptional children, physical limitations, causes and effects, personality factors, psychological implications, and specific educational approaches to their individual problems. Field trips and class observations. P. 403. Special sections in each category of the handicapped 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; 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.

585. **Speech for the Hearing Impaired** (3) II Oral/aural communication development; methods for assessing and teaching speech and auditory skills.

593. **Internship**
Note: Special sections in each category of the handicapped to be arranged in the departmental office.

594. **Practicum**
- b. Communication Development for Hearing Impaired Children (1 to 6) I II
- c. Reading and School Subjects for the Deaf (1 to 10) I II

595. **Colloquium**
- a. Behavioral Disorders (3) I Open to majors only.

597. **Workshop**
- a. Personal Management and Daily Living Skills for the Visually Handicapped (1 to 3) I II
- b. Orientation and Mobility of the Visually Handicapped (1 to 3) I II
- d. Role and Function of the Resource Teacher (1 to 3) I II

616. **General School Administration** (3) I (Identical with Ed.F.A. 616)

620. **Applied Research with 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.


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. Neurologically Impaired (1 to 4) I II
- h. Multidisciplinary Approaches to Preschool Handicapped (1) I P, 403; CR 575.
- i. Working with Families of Young Handicapped Children (1) II P, 403, 495g.
- j. Application of Child Development Research to Exceptional Children (1) II P, 403, 495g.

**SPEECH AND HEARING SCIENCES**

Associate Professor Linda Swisher
Director, Speech-Language Clinic: Anthony B. DeFeo
Assistant Director, Speech-Language Clinic: Linda B. Lilley
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)

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.

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 II Open to majors only. P. 471R 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.


484. Audiologic 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. 280.

486. Child Audiology (3) GC II Study of the development and disorders of the auditory system; audiological, evaluation and differential diagnosis in infants and children; psychological, auditory, and educational aspects of the habilitation of aurally handicapped children. P. 280, 483.


500. Introduction to Graduate Study (3) I Introduction to the conduct of research and grad. study in speech and hearing sciences.

553R. Language Disorders in Preschool Children (2) II 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) II 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 P. 554R or CR.

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. 481. 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.

565L. Aerodynamic Evaluation and Management of the Speech Mechanism Laboratory (1) P. CR 565R.

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.

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; theoretical 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.

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. Audiolologic 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.

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) I II
   b. Clinical Audiology (1 to 3) I II
   c. Hearing—Physiology and Psychophysics (1 to 3) I II
   d. Language and Language Disorders (1 to 3) I II
   e. Speech Pathology (1 to 3) I II

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.

SPEECH COMMUNICATION

Professors Henry L. Ewbank, Andrew A. King, Frank K. La Ban, Klonda Lynn (Emerita), Alethea S. Mattingly (Emerita), George F. Sparks (Emeritus)

Associate Professors Patricia D. Van Metre, Acting Head, James W. Davis, Mary Z. Maher, Ronald J. Maton, Robert W. Sankey, David A. Williams

Assistant Professor Uvieja Good Leighton

Lecturers William E. Bailey, Timothy A. Browning, F. Dave Nott
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.


412. Organizational Communication (3) GC II Analysis of interpersonal and group communication practices affecting goal achievement in business, governmental, and professional organizations. P, 300 or Mgmt. 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 1984-85 Intensive reading and analysis of the works of major rhetorical theorists from the 18th century through the present. P, 414.

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 I 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 1984-85 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 1983-84 History and criticism of American religious and reform speakers from Colonial times to the present. 424b: II 1984-853 Analysis of American political speaking from 1765 to the present. P, six units of speech. 424a is not prerequisite to 424b.

436. Oral Interpretation of Shakespeare (3) GC I 1983-84 Character analysis and presentation of selected scenes from representative comedies, histories, and tragedies. P, 237 or 238.

445. Oral Interpretation of Poetry (3) GC I Types of poetry analyzed, with emphasis on their differentiation for oral presentation; preparation for oral and public presentations. 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 1983-84 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.
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<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>467</td>
<td>English Phonetics</td>
<td>(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.</td>
</tr>
<tr>
<td>525</td>
<td>Rhetorical Criticism</td>
<td>(3) I 1983-84 Systems of criticism; rationale of approaches to the critical act; analysis of representative criticism of rhetorical events and movements.</td>
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<tr>
<td>567</td>
<td>Applied Phonetics</td>
<td>(3) II 1984-85 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.</td>
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<tr>
<td>610</td>
<td>Rhetorical and Communication Theory I</td>
<td>(3) I Historical development of theoretical and pedagogical perspectives on the process of generating and understanding public discourse.</td>
</tr>
<tr>
<td>620</td>
<td>Rhetorical and Communication Theory II</td>
<td>(3) II Contemporary approaches to the process of human communication, psychological, philosophical, linguistic, literary, behavioral, and other perspectives.</td>
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<tr>
<td>636</td>
<td>Interpretation of Individual Literary Styles</td>
<td>(3) I 1984-85 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.</td>
</tr>
<tr>
<td>637</td>
<td>Historical Theories of Oral Interpretation</td>
<td>(3) II 1983-84 Mechanical and natural schools of oral interpretation, their backgrounds, and their influence upon modern teaching and performance.</td>
</tr>
<tr>
<td>638</td>
<td>Modern Theories of the Performance of Literature</td>
<td>(3) II 1984-85 Twentieth-century theories of interpretation and their application, with emphasis on developing a rationale for criticism of performed literature.</td>
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<tr>
<td>660</td>
<td>Research Methodologies I</td>
<td>(3) I Historical and critical methods of investigating, analyzing, and evaluating rhetoric and literature.</td>
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<tr>
<td>670</td>
<td>Research Methodologies II</td>
<td>(3) II Experimental, descriptive, statistical, and computer-assisted methods of investigating, analyzing, and evaluating human communication.</td>
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<tr>
<td>698</td>
<td>Seminar</td>
<td>a. Rhetorical Criticism (3) [Rpt./1] I II</td>
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<td>b. Oral Interpretation (3) [Rpt./1] I II</td>
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<td>c. Rhetorical Theory (3) [Rpt./1] I II</td>
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<td>d. Speech Education (3) [Rpt./1] I II</td>
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<td>e. Communication Theory (3) [Rpt./1] I II</td>
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<td>f. Linguistic Investigations and Applications (3) I II (Identical with Ling. 696I)</td>
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<td>g. Argumentation (3)</td>
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**STATISTICS**

Professors Jean E. Weber, **Head**, Bruno Baldessari, Takis Papioannou

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.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>461</td>
<td>Elements of Statistics</td>
<td>(3) GC I II Advanced degree credit available for nonmajors only. (Identical with Math. 461)</td>
</tr>
<tr>
<td>464</td>
<td>Theory of Probability</td>
<td>(3) GC I (Identical with Math. 464)</td>
</tr>
<tr>
<td>465</td>
<td>Statistics for the Medical Sciences</td>
<td>(4) GC I Standard and nonparametric one- and two-sample procedures, ANOVA designs, linear and multiple regression, bioassay, prohibit analysis, and contingency tables. 3R, 3L. Not open to majors. P, two semesters of calculus. (Identical with Tox. 465)</td>
</tr>
<tr>
<td>466</td>
<td>Theory of Statistics</td>
<td>(3) GC II (Identical with Math. 466)</td>
</tr>
<tr>
<td>468</td>
<td>Applied Stochastic Processes</td>
<td>(3) GC II (Identical with Math. 468)</td>
</tr>
<tr>
<td>562</td>
<td>Sampling Theory and Methods</td>
<td>(3) II Introduction to planning, execution, and analysis of surveys, methods of sampling, estimation of population values, estimation of sampling error and efficiency of methods. P, one course in stat.</td>
</tr>
<tr>
<td>563</td>
<td>Nonparametric Statistics</td>
<td>(3) I Distribution free statistics, chi-square tests, related samples, independent samples, correlations, tests of significance, confidence bands. P, one course in stat.</td>
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</table>


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.

665. Applied Time Series Analysis (3) I Methods used in time series analysis, with emphasis on applications, including computer analysis of data and consideration of violations of model assumptions. P, 660.

666. Advanced Experimental Design (3) II Design and analysis of complex experiments, including methods of confounding higher order interaction terms, partial confounding, incomplete block designs and response surface methodology. P, 663.

SYSTEMS AND INDUSTRIAL ENGINEERING

Professors John S. Ramberg, Head, Lucien Duckstein, William R. Ferrell, Donald G. Schultz, Roger J. Weldon (Emeritus), A. Wayne Wymore, Sidney J. Yakowitz
Associate Professors Robert L. Baker, Donald R. Davis, Duane L. Dietrich, J. George Shanthikumar
Assistant Professors Joseph J. Pignatiello, Jr., Suvrajeet Sen, Chiang Wang

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, at the student’s option, six units of thesis, a three-unit master’s report, or neither. The nature of the final oral examination depends upon whether the student has chosen the thesis option, the report option, or the course-work option. Additional details concerning the requirements of the master’s or doctor’s degree may be obtained on request from the department.

405. Digital Systems Simulation (3) GC I II Simulation modeling of systems using digital computer languages, emphasizing random variate generation, Monte Carlo, timekeeping structures and statistical design and analysis of simulation experiments; introduction to continuous simulation. P, 420, 440.

406. Engineering Quality Control (3) GC I 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, 420 or A.M.E. 413a. (Identical with A.M.E. 406)

410. Analysis, Design and Measurement of Work (3) GC II Principles of the analysis, design, prediction and measurement of industrial work. Emphasis on application, physiological constraints, safety, morale and equity in the industrial setting. P, 310.


422. Engineering Decision Making under Uncertainty (3) GC I 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, 420.

442. Design of Delivery/Distribution Systems (3) GC II 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. 405, 420, 440.

450. Deterministic Systems (3) GC II Analysis and design of linear deterministic systems in both the time and frequency domains using Fourier analysis, Laplace transforms and state space methods. Attention will be given to modelling physical and engineering systems. P. Math. 253.

453. Deterministic Control Systems (3) GC I The analysis and synthesis of deterministic linear control systems, with emphasis on design using both frequency-domain and state-variable approaches. P. 450.

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, 440.


465. Manufacturing Systems, Modelling, and Analysis (3) GC II Topics in production and systems with the main focus on automatic transfer lines, flow lines, dynamic job shops, flexible manufacturing systems, and group technology (cellular manufacturing) for discrete part manufacturing. P. 440.

470. Microprocessors in System Control (3) GC II Digital logic; microprocessor architecture, programming and input/output interfacing; control and monitoring of external devices; serial input/output and communication methods; microcomputer systems, busses and software. Hardware and software exercises. P. 170, E.C.E. 208.

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. 450.

474. Human Interaction with Computers and Software (3) GC II 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.

475. Information System Design (3) GC II 1983-84 The application of systems engineering methodology to the design, analysis, and implementation of information and information retrieval systems. P. 250 or 454.


505. Digital Systems Simulation (3) II Continuation of 405, with emphasis on current research problems including random variate generation, Monte Carlo, language development, and statistical analysis of output. P. 405.

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)

510. Human Factors in Complex Systems (3) I Advanced topics in human performance, including technological approaches to facilitating group and individual valuation, estimation, prediction and problem solving. P. 310 or 411.


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. P. 440.

544. Linear Optimization (3) I Advanced linear-programming concepts and methods for continuous and discrete variable problems; large-scale optimization; theory and computation; applications to operations research and optimal control. P. 340.

550. Theory of Linear Systems (3) I An intensive study of linear systems from the state-space viewpoint, including criteria for observability, controllability, and minimal realizations; aspects of optimal control and filter theory. P. 450 or Math. 322.

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. 440.

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) II Systems design versus operation; multi-objective simplex; goal programming and other distance-based techniques; multi-attribute utility; techniques with qualitative criteria; interactive, quanainteractive and dynamic approaches; model choice; resource engineering applications. P. 440.


581. **Operations Research in Health Care Delivery** (3) II The role of quantitative decision-making in health care delivery; mathematical and statistical modeling techniques useful in evaluating quality and cost of health care from an institutional perspective. P. 440. (Identical with P.P.P.A. 581)

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.

644. **Nonlinear Optimization** (3) II Theory of mathematical programming; convex analysis, duality, and optimality; investigation of linear, quadratic, geometric, and dynamic programming with applications in operations research, statistics, and optimal control. P. 544.

650. **Mathematical Theory of System Design** (3) II Rigorous development of the tricotyledon theory of system design. P. 554.

**TOXICOLOGY**

*Committee on Toxicology*

Professors H. Vasken Aposhian (Cellular and Developmental Biology), Thomas F. Burks (Pharmacology), Milos Chvapil (Surgery), J. Wesley Clayton (Pharmacology and Toxicology), Jack R. Cole (Pharmaceutical Sciences), Larry A. Crowder (Entomology), Richard C. Froede (Pathology), Albert Picchioni (Pharmacology and Toxicology), I. Glenn Sipes (Pharmacology and Toxicology), Cornelius Steelink (Chemistry)

Associate Professors Dean E. Carter (Pharmacology and Toxicology), Lois E. Prosser (Nursing)

Director Jarvis Moyers (University Analytical Center)

The interdisciplinary toxicology program is coordinated by the Committee on Toxicology, composed of faculty from various colleges in the university. The program 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.
For a complete list of available courses, refer to Pharmacology and Toxicology and to Pharmacology elsewhere in this catalog.

TURKISH
(See Oriental Studies)

URBAN PLANNING

Committee on Urban Planning

Professors Arthur L. Silvers (Urban Planning), Acting Chairperson, Robert D. Carpenter (Urban Planning), James P. Logan (Policy), Lawrence D. Mann (Urban Planning), Norman Williams, Jr. (Urban Planning)

Associate Professor Michael K. Block (Policy)

Assistant Professors Reid H. Ewing (Policy), Vernon L. Greene (Policy)

The Committee on Urban Planning offers a program leading to the Master of Science degree with a major in urban planning.

The program provides competence for analyzing systemic causes underlying public sector problems, and for evaluating likely impacts of program or policy alternatives. Students may choose specializations either in public sector planning or in policy analysis. (Students pursuing private sector careers may develop a specialization in corporate planning.) Options may then be developed in land use and the environment, health and human resources, housing and transportation, and policy planning, for application in organizations and governmental agencies at all levels.

Above-average performance on the verbal, quantitative, and analytical aptitude portions of the Graduate Record Examination, and an academic average of approximately "B" or better, are required for admission consideration by the committee. Applicants should also submit three letters of recommendation. Students who enter without prior course work in economics, sociology, anthropology, or political science will be required to take appropriate courses early in their programs of study. Such courses will count as electives.

Fifty-four graduate units (two academic years and one summer session) are required for completion of the Master of Science with a major in urban planning. All students are required to complete the core program, consisting of 36 units, including Mgmt. 552 or Geog. 457, Econ. 500a, U.Pl. 604, 605, 609, 693, 610a-610b, P.P.P.A. 610b, 582a, M.I.S. 501, and U.Pl. 608 or 696c. In addition, students must complete 18 units chosen from approved courses or a coherent set of courses providing depth in the definable fields of planning, proposed by the student and approved by the faculty. The final requirement consists of two parts. The first of these may be satisfied either by a thesis or by a major report on a real planning experience. The second part is a final examination covering the whole of the student's program of study.

457. Statistical Techniques in Geography and Planning (3) GCI (Identical with Geog. 457)

501. Development of Urban Planning (3) I Survey of the historical development of the planning profession; the evolution of American planning as a response to urban development. Open to majors only. Credit allowed for this course or 300, but not for both.

503. 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.

506. Fundamentals of Physical Planning (3) I Basic considerations in site analysis and planning, and transportation and utility systems; subdivision planning and plat review. P. 501.
507. **Social Service Planning** (3) [Rpt./6 units] I II Survey of the variety of planning efforts designed specifically to increase social welfare through the delivery of services using historical, comparative, and evaluative perspectives.

563. **Perception of Environment** (3) I II (Identical with Geog. 563)

565a-565b. **Principles of Transportation Planning** (3-3) I II (Identical with C.E. 565a-565b)

575. **Housing and Residential Areas** (3) I II Physical, social, and economic aspects of housing development and residential areas and their relationship to other land uses and functions.

596. **Seminar**

u. **Interdisciplinary Environment-Behavior-Design** (3) I (Identical with Idls. 596u, which is home)

604. **Analytic Methods in Planning and Management** (3) I 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 Mgmt. 552. (Identical with P.P.P.A. 604)

605. **Planning Theories and Perspectives** (3) I II A critical evaluation of normative and methodological assumptions of alternative planning models, with emphasis on developing a perspective on contemporary planning issues. P. 501.

608. **Planning Law** (3) I II Land-use controls; the law of zoning, exclusionary zoning, restrictive covenants, comprehensive plan, environmental protection, eminent domain, nuisance.

609. **Problems of Urban Change** (3) I II Problems presented by growth and change in the modern city; possible planning solutions. Field trips. Credit allowed for this course or Geog. 379, but not for both. (Identical with Geog. 609)

610a-610b. **Projects in Urban and Regional Planning** (2-3) Lab. and field projects simulating various aspects of professional practice. Open to majors only. P. 12 units toward M.S., 605.

659. **Growth Management** (3) I II 1984-85 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)

669. **Preservation of Historic Environments** (3) I II 1983-84 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)

696. **Seminar**

a. **The General Plan** (3) [Rpt./6 units] I II
b. **Land-Use Regulation** (3) [Rpt./6 units] I II
c. **Planning Administration** (3) [Rpt./6 units] I II
d. **Energy Planning** (3) [Rpt./6 units] I II
e. **Alternative Urban Futures** (3) [Rpt./6 units] I II
f. **Environmental Planning** (3) [Rpt./6 units] I II

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**URDU**

*(See Oriental Studies)*

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**VETERINARY SCIENCE**


Associate Professors Ronald W. Hillwig, Gavin L. Meerdink, J. Glenn Songer, Charles R. Sterling

Assistant Professor Lynn A. Joens

Lecturer Ted H. Noon

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, General Biology, or Microbiology. 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 systems of domestic animals. 400b: Urinary, digestive, endocrine and reproductive systems P, G.Bio. 104, Chem. 103a-103b, 104a-104b.

403. Parasites of Domestic Animals (2) GC I Biology, distribution, economic importance, pathogenicity, diagnosis, treatment, and control of parasites of domestic animals, with emphasis on the disease-producing capabilities of parasites. P, four units of bio. (Identical with Ento. 403)

405. Animal Diseases (3) GC I Integration of management, husbandry, and preventive veterinary medicine, as related to animal diseases.

420. Pathogenic Microbiology (4) GC I II (Identical with Micr. 420)

423R. General Pathology (3) GC II Pathogenesis, pathophysiology and morphologic changes of human and animal diseases. P, Micr. 202 or 420. (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)

450. Medical Mycology (4) GC I II (Identical with Micr. 450)


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 G.Bio. 459)

489. Parasitology (4) GC S (Identical with G.Bio. 489)

601. Experimental Surgery (2) II 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. (Identical with Micr. 601)

WATER RESOURCES ADMINISTRATION
(See Hydrology and Water Resources)

WATERSHED MANAGEMENT
(See Renewable Natural Resources)

WILDLIFE AND FISHERIES SCIENCE
(See Renewable Natural Resources)

ZOOLOGY
(See Cellular and Developmental Biology, Ecology and Evolutionary Biology, and General Biology)
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