GRADUATE CATALOG
1989-90
1990-91
HE UNIVERSITY OF ARIZONA RECORD

XXXII NO. 3  June, 1989

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

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

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Graduate Admissions Office
Administration 322
The University of Arizona
Tucson, Arizona 85721
(602) 621-3132

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Chart of Degrees

Map
Academic Divisions of the University

More detailed information may be found under listings for the specific school, department, or committee.

College of Agriculture.

Schools: School of Family and Consumer Resources (with programs in Family Studies; Clothing and Textiles; Interior Design; Counseling and Guidance; Home Economics Education; Consumer Studies); School of Renewable Natural Resources (with programs of Landscape Resources; Range Resources; Forest Watershed Resources; Wildlife Fisheries and Recreation Resources). Departments of: Agricultural Economics; Agricultural Education; Agricultural Engineering; Animal Sciences; Entomology; Nutrition and Food Science; Plant Pathology; Plant sciences; Soil and Water Science; Veterinary Science. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology.

College of Architecture.

College of Arts and Sciences. Schools: School of Music; Graduate Library School. Departments of: Anthropology; Art; Astronomy; Atmospheric Sciences; Chemistry; Classics; Communication; Computer Science; Drama; Ecology and Evolutionary Biology; English; French and Italian; Geography and Regional Development; Geosciences; German; History; Journalism; Linguistics; Mathematics; Media Arts; Oriental Studies; Philosophy; Physics; Planetary Sciences; Political Science; Psychology; Russian and Slavic Languages; Sociology; Spanish and Portuguese; Speech and Hearing Sciences; Statistics. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology. Committees on: Dance; Russian and Soviet Studies.

College of Business and Public Administration. Schools: Karl Eller Graduate School of Management; School of Public Administration and Policy. Departments of: Accounting; Economics; Finance and Real Estate; Management and Policy; Management Information Systems; Marketing.

College of Education. Divisions of: Educational Foundations and Administration; Language, Reading, and Culture; Special Education and Rehabilitation; and Teaching and Teacher Education.

College of Engineering and Mines. Departments of: Aerospace and Mechanical Engineering; Chemical Engineering; Civil Engineering and Engineering Mechanics; Electrical and Computer Engineering; Hydrology and Water Resources; Materials Science and Engineering; Mining and Geological Engineering; Nuclear and Energy Engineering; Systems and Industrial Engineering.

College of Law.

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

College of Nursing.

College of Pharmacy. Departments of: Pharmaceutical Sciences; Pharmacology and Toxicology; Pharmacy Practice.

School of Health-Related Professions. Divisions of: Community and Environmental Health; Medical Technology. Department of: Exercise and Sport Sciences.

Graduate College. Committees on: American Indian Studies; Applied Mathematics; Arid Lands Resource Sciences; Cancer Biology; Comparative Literature and Literary Theory; Environment and Behavior; Genetics; Gerontology; History and Philosophy of Science; Latin American Studies; Medieval Studies; Neuroscience; Nutritional Sciences; Optical Sciences; Pharmacology and Toxicology; Physiological Sciences; Planning; Plant Protection; Remote Sensing.

General Departments. School of Military Science, Naval Science, and Military Aerospace Studies.

University Departments. Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology.

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

Extended University and the Summer Session.

The University Libraries.
Abbreviation Guide

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

a.ec. agricultural economics
a.ed. agricultural education
a.en. agricultural engineering
a.m.e. aerospace and mechanical engineering
acct. accounting
agri. agriculture
A.In.s. American Indian studies
an.s. animal sciences
anat. anatomy
anes. anesthesiology
appl. applied mathematics
ar.l. arid lands resource sciences
arch. architecture
art art
astr. astronomy
atmo. atmospheric sciences
b.ad. business administration
bioc. biochemistry
Bl.s. Black studies
c.bio. cancer biology
c.e. civil engineering
ch.e. chemical engineering
chem. chemistry
clas. classics
comm. communication
coun. counseling and guidance
cp.lt. comparative literature and literary theory
crl. critical languages
c.s. consumer science
c.sc. computer science
c.t. clothing and textiles
dnc. dance
dram. drama
e.c.e. electrical and computer engineering
e.m. engineering mechanics
ecol. ecology and evolutionary biology
econ. economics
ed.a. educational administration
ed.p. educational psychology
educ. education
Engl. English
engr. engineering
ento. entomology
ex.s.s. exercise and sport sciences
f.c.m. family and community medicine
f.c.r. family and consumer resource
fin. finance and real estate
Fre. French
f.s. family studies
g.en. geological engineering
gene. genetics
geog. geography and regional development
geos. geosciences
Ger. German
ger. gerontology
Grik. Greek
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.t.p. health-related professions
hum. humanities
hydr. hydrology
i.d. interior design
idis. interdisciplinary
l.med. internal medicine
Ita. Italian
jour. journalism
l.ar. landscape architecture
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# Graduate Calendar

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<tr>
<td>Last day to submit approved, library-ready copies of thesis for December completion</td>
<td>Dec. 14, Th</td>
<td>Dec. 13, Th</td>
</tr>
<tr>
<td>Last day to pay fees for master’s and specialist degree candidacy and thesis processing</td>
<td>Dec. 20, W</td>
<td>Dec. 19, W</td>
</tr>
<tr>
<td>Semester examinations end</td>
<td>Dec. 20, W</td>
<td>Dec. 19, W</td>
</tr>
<tr>
<td>Commencement</td>
<td>Dec. 21, Th</td>
<td>Dec. 20, Th</td>
</tr>
</tbody>
</table>

## Second Semester 1989-90 1990-91

<table>
<thead>
<tr>
<th>Event</th>
<th>1989-90</th>
<th>1990-91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>Jan. 10, W</td>
<td>Jan. 9, W</td>
</tr>
<tr>
<td>Martin Luther King Holiday</td>
<td>Jan. 15, M</td>
<td>Jan. 21, M</td>
</tr>
<tr>
<td>Last day for doctoral preliminary oral examination for May completion</td>
<td>Jan. 16, Tu</td>
<td>Jan. 15, Tu</td>
</tr>
<tr>
<td>Last day to file Application for Candidacy for May completion of doctoral requirements</td>
<td>Jan. 16, Tu</td>
<td>Jan. 15, Tu</td>
</tr>
<tr>
<td>Deadline for senior petitions for graduate credit</td>
<td>Jan. 18, Th</td>
<td>Jan. 16, W</td>
</tr>
<tr>
<td>Last day to register for credit, to add courses, and to change from no credit to credit</td>
<td>Jan. 18, Th</td>
<td>Jan. 16, W</td>
</tr>
<tr>
<td>Last day to file Master’s Degree Study Program for completion in May</td>
<td>Jan. 29, M</td>
<td>Jan. 28, M</td>
</tr>
<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Feb. 6, Tu</td>
<td>Feb. 5, Tu</td>
</tr>
<tr>
<td>Spring recess</td>
<td>Mar. 10-18, Sa-Su</td>
<td>Mar. 9-17, Sa-Su</td>
</tr>
<tr>
<td>Last day to file Master’s Degree Study Program for summer completion</td>
<td>Mar. 23, F</td>
<td>Mar. 22, F</td>
</tr>
<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Mar. 27, Tu</td>
<td>Mar. 26, Tu</td>
</tr>
<tr>
<td>Last day to file Report on Master’s Final Examination and thesis, if any, for preliminary approval by Graduate College</td>
<td>Apr. 16, M</td>
<td>Apr. 15, M</td>
</tr>
<tr>
<td>Last day to take doctoral final oral examination for May completion</td>
<td>Apr. 16, M</td>
<td>Apr. 15, M</td>
</tr>
<tr>
<td>Last day to pay fees for doctoral degree candidacy and dissertation processing and microfilming</td>
<td>Apr. 19, Th</td>
<td>Apr. 18, Th</td>
</tr>
<tr>
<td>Last day to submit approved, library-ready copies of dissertation for May completion</td>
<td>Apr. 20, F</td>
<td>Apr. 19, F</td>
</tr>
<tr>
<td>Class and laboratory sessions end</td>
<td>May 2, W</td>
<td>May 1, W</td>
</tr>
<tr>
<td>Semester examinations begin</td>
<td>May 4, F</td>
<td>May 3, F</td>
</tr>
<tr>
<td>Semester examinations end</td>
<td>May 11, F</td>
<td>May 10, F</td>
</tr>
<tr>
<td>Commencement</td>
<td>May 12, Sa</td>
<td>May 11, Sa</td>
</tr>
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</table>

## Presession 1990 1991

<table>
<thead>
<tr>
<th>Event</th>
<th>1990</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>May 14, M</td>
<td>May 13, M</td>
</tr>
<tr>
<td>Holiday—No classes</td>
<td>May 28, M</td>
<td>May 27, M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>June 2, Sa</td>
<td>June 1, Sa</td>
</tr>
</tbody>
</table>

## First Summer Session

<table>
<thead>
<tr>
<th>Event</th>
<th>1990</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>June 4, M</td>
<td>June 3, M</td>
</tr>
<tr>
<td>Holiday—No classes</td>
<td>July 4, W</td>
<td>July 4, Th</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>July 5, Th</td>
<td>July 5, F</td>
</tr>
</tbody>
</table>

## Second Summer Session

<table>
<thead>
<tr>
<th>Event</th>
<th>1990</th>
<th>1991</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>July 9, M</td>
<td>July 8, M</td>
</tr>
<tr>
<td>Last day to submit Report on Master’s Final Examination and thesis, if any, for preliminary approval by Graduate College</td>
<td>July 16, M</td>
<td>July 15, M</td>
</tr>
<tr>
<td>Last day to submit approved, library-ready copies of master’s thesis for August completion</td>
<td>July 25, W</td>
<td>July 24, W</td>
</tr>
<tr>
<td>Last day to take doctoral final oral examination for August completion</td>
<td>Aug. 7, Tu</td>
<td>Aug. 6, Tu</td>
</tr>
<tr>
<td>Last day to pay fees for degree candidacy, thesis and dissertation processing and microfilming</td>
<td>Aug. 8, W</td>
<td>Aug. 7, W</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>Aug. 8, W</td>
<td>Aug. 7, W</td>
</tr>
</tbody>
</table>
x Officio

Jane Molford ........................................... Governor of Arizona
Diane Bishop ........................................... State Superintendent of Public Instruction

Appointed

stick McWhortor, Assistant Treasurer ............. May, 1989
ondal G. Shrophshire ................................ January, 1990
Jack Pfister, LL.B ..................................... January, 1990
Sarah M. Aultander, Ph.D ........................................ January, 1994
mber Chanen, President ................................ January, 1992
ondal Hitchcock, Secretary .............................. January, 1994
other N. Capin, M.Ed., Treasurer .................... January, 1994
ndrew D. Hurwitz .................................... January, 1994
ugust J. Wall ............................................. January, 1996

University Administration

18dministrative Officers

Year of first University appointment in parentheses after each name)

kerry kopler (1982) ...................................... President of the University

ack R. Cule (1957), Acting Provost
en E. Tuce (1958), Senior Vice President for Administration and Finance
ilan Beigel (1970), Vice President of University Relations and Development
arah A. Blake (1983), Vice President for Planning and Budgeting
ichael A. Cusanoovich (1969), Vice President for Research and Dean of the Graduate College
yndon J. Noodrand, Jr. (1963), Vice President for Student Affairs
ames E. Delen (1987), Vice Provost for Medical Affairs
George H. Davis (1970), Vice Provost for Academic Affairs
iber B. Weaver (1958), Executive Vice President Emeritus
ichard M. Edwards (1959), Vice President Emeritus for Student Relations
fmr Richard Kassander (1954), Vice President Emeritus for Research
ywood E. Carr (1954), Treasurer and Contracting Officer Emeritus

Graduate College Officers

michael A. Cusanoovich (1969), Vice President for Research and Dean of the Graduate College
henry Dawen Rhodes (1943), Dean Emeritus of the Graduate College
ail Harrison (1976), Assistant Vice President for Research; Acting Vice Dean of the Graduate College
Adela A. Allen (1968), Associate Dean of the Graduate College
uris Bradford Merritt (1949), Associate Dean Emeritus of the Graduate College

Deans

Rosaid E. Andrews (1985), Dean of Students
J. Lytle Bootman (1978), Acting Dean, College of Pharmacy
Willis R. Brewer (1949), Dean Emeritus, College of Pharmacy
ames E. Delen (1987), Dean, College of Medicine
Gary D. Farnham (1985), Dean, College of Education
kenney F. Hegland (1970), Acting Dean, College of Law
Robert C. Hersherberger (1988), Dean, College of Architecture

Robert Leslie Hull (1964), Dean Emeritus of the College of Dental Medicine
Donald J. Irving (1992), Dean of the Faculty of Fine Arts, College of Arts and Sciences
Annette Kolody (1989), Dean, Faculty of Humanities
Edgar J. McCullough, Jr. (1957), Dean of the Faculty of Science, College of Arts and Sciences
Darrel S. Metcalfe (1956), Dean Emeritus, College of Agriculture
Harold E. Myers (1956), Dean Emeritus, College of Agriculture
L. Clare Parson (1987), Dean, College of Nursing
f. Robert Pauftien (1964), Dean Emeritus, College of Education
Herbert D. Rhodes (1943), Dean Emeritus, College of Agriculture
Eugene G. Sander (1987), Dean, College of Agriculture
Lise Sigelman (1987), Dean, Faculty of Social and Behavioral Sciences
Ernest T. Smrodon (1988), Dean, College of Engineering and Mines
Kenneth R. Smith (1980), Dean, College of Business and Public Administration
Gladys E. Sorensen (1958), Dean Emerita, College of Education
Robert S. Swob (1942-44, 1946), Dean Emeritus of Students
David L. Windsor (1945), Dean Emeritus of Admissions and Records

Graduate Council

Adela A. Allen, Associate Dean of the Graduate College
Jan Atwood, Professor of Nursing
J. Norman Austin, Professor of Classics
Thomas Bata, Associate Professor of Aerospace and Mechanical Engineering
John Bergan, Professor of Educational Foundations and Administration
Michael A. Cusanoovich, Vice President for Research and Dean of the Graduate College, Chair
Roger Dahood, Professor of English
Duane L. Dietrich, Associate Professor of Systems and Industrial Engineering
Lue Fink, Professor of Planetary Sciences
Barry Ganapol, Professor of Nuclear and Energy Engineering
Jennifer D. Hall, Professor of Molecular and Cellular Biology
Gail J. Harrison, Acting Vice Dean of the Graduate College
Roy A. Johnson, Professor of Music
Noel D. Matkin, Professor Speech and Hearing Sciences
Michael Meyersohn, Professor of Pharmaceutical Sciences
Virginia Richardson, Associate Professor of Teaching and Education
Susan M. Steele, Professor of Linguistics
Spencer R. Tilley, Professor of Geosciences
Elias Vasquez, Student Member
Melanie Wallendorf, Associate Professor of Marketing
Arthur W. Warrick, Professor of Soil and Water Science
Mary C. Wetzel, Professor of Psychology
Maria Yoshimura, Student Member

Committee on Graduate Study

Patricia L. Anders (1990), Associate Professor of Reading
Jay B. Anderson (1989), Professor of Anatomy
Stanley Bashkin (1989), Professor of Physics
Cari T. Bernhol (1990), Associate Professor of English
Hans J. Bohner (1991), Associate Professor of Biochemistry
Don P. Bourque (1991), Associate Professor of Biochemistry and of Nutrition and Food Science
John P. Boyd (1991), Professor of Music
Klaus Brenzel (1990), Professor of Pharmacology
Paul A. Carter (1990), Professor of History
Mohinder Cheema (1989), Professor of Mathematics
John H. Chiotti (1990), Associate Professor of Anthropology
James R. Clay (1992), Professor of Mathematics
J. Wesley Clayton, Jr. (1990), Professor of Pharmacology and Toxicology
Russell P. Davis (1989), Associate Professor of Ecology and Evolutionary Biology
Gary D. Dietrich (1990), Associate Professor of Exercise and Sport Sciences
Walter Doyle (1990), Professor of Teaching and Learning

Alexander Dunkel (1992), Associate Professor of Russian and Slavic Languages
Christopher Easto (1991), Assistant Professor of Geosciences
Siegfried Enser (1990), Professor of English
William Epstein (1991), Professor of English
Richard L. Erickson (1991), Associate Professor of Family and Consumer Resources
Patricia Fairchild (1989), Associate Professor of Exercise and Sport Sciences
Cundus Fernandez (1990), Professor of Chemistry
Leslie S. Foster (1989), Professor of Chemistry
Peter A. Franken (1989), Professor of Optical Sciences and Technologies
Robert L. Galf (1992), Professor of Atmospheric Sciences
Juan J. Guadob (1992), Professor of Spanish and Portuguese
Robert I. Gilberston (1991), Professor of Plant Pathology
Kenneth S. Goodman (1990), Professor of Language, Reading and Culture
Robert T. Grant (1989), Professor of Educational Foundations and Administration
Robert L. Hamblin (1991), Professor of Sociology
Kathryn Hayth (1991), Professor of Family and Consumer Resources
Richard Hawkins (1992), Professor of Renewable Natural Resources
Donald Heckerman (1989), Associate Professor of Economics
Jane Hill (1989), Professor of Anthropology
William R. Hodgson (1989), Professor of Speech and Hearing Sciences
William Hoffman (1990), Professor of Astronomy
Alan J. Howarth (1991), Assistant Professor of Plant Pathology
Donna R. Iams (1991), Associate Professor of Family and Consumer Resources
Theodore Jacob (1991), Professor of Family and Consumer Resources
Henning Jensen (1991), Professor of Philosophy
Robert G. Jensen (1989), Professor of Biochemistry and of Plant Sciences
Roger C. Jones (1990), Professor of Electrical and Computer Engineering
Marvin K. Kann (1989), Professor of Psychology
Konrad Keck (1989), Professor of Molecular and Cellular Biology
David A. King (1992), Professor of Renewable Natural Resources
Paul R. Krausman (1990), Associate Professor of Wildlife and Fisheries Science
Philip Krutzsch (1989), Professor of Anatomy
Fang-K. La Ban (1992), Professor of Drama
Lon N. Larson (1992), Assistant Professor of Pharmacy Practice
Christopher A. Leadem (1992), Assistant Professor of Anatomy
Gordon S. Lehman (1992), Associate Professor of Watershed Management
Adrienne Lehrer (1991), Professor of Linguistics
Robert C. Leonard (1991), Professor of Sociology
Jerald S. Levy (1991), Professor of Anthropology
John W. Little (1991), Associate Professor of Biochemistry and of Molecular and Cellular Biology
David C. Lynch (1990), Associate Professor of Materials Science and Engineering
Allan J. Malveck (1991), Professor of Civil Engineering and Engineering Mechanics
Paul S. Martin (1988), Professor of Geosciences
Steven D. Martinson (1992), Associate Professor of German
Kazuo Matsuda (1989), Associate Professor of Molecular and Cellular Biology
Allan D. Matthias (1991), Associate Professor of Soil Sciences
Warren L. May (1992), Professor of Mathematics
Jeanne M. McCarthy (1990), Professor of Special Education and Rehabilitation
D. Keith McElroy (1990), Associate Professor of Art
Laurence C. McIntyre (1990), Professor of Physics
John A. Mills (1991), Associate Professor of English
Luis Mill (1990), Associate Professor of Language, Reading and Culture
Mary G. Morgan (1992), Associate Professor of Anthropology
James E. Mulvania (1989), Professor of Chemistry
Carolyn L. Murdash (1990), Associate Professor of Nursing
Edward W. Murphy (1990), Professor of Music
Eugene W. Myers, Jr. (1990), Associate Professor of Computer Science
Richard T. Newcomb (1991), Professor of Mining and Geological Engineering
John Obrzut (1990), Professor of Educational Psychology
John W. Olsen (1990), Associate Professor of Psychology
Russell E. Peterson (1990), Professor of Aerospace and Mechanical Engineering
Linda R.F. Phillips (1990), Associate Professor of Nursing
Peter E. Pickens (1991), Professor of Molecular and Cellular Biology
David A. Plane (1992), Associate Professor of Geography and Regional Development
Frank Porreca (1992), Associate Professor of Pharmacology and Experimental Therapeutics
Joseph M. Promis (1991), Professor of Spanish and Portuguese
Hamid R. Qafsheh (1992), Professor of Oriental Studies
Suresh S. Raval (1992), Professor of English
Atkinson, George H., Professor of Chemistry and of Optical Sciences
Aamodt, Agnes M, Professor Emerita of Nursing
Abbey, Edward P., Professor of English
Abrams, Herbert K., Professor Emeritus of Family and Community Medicine
Amsden, Rodney Dean, Assistant Professor of Internal Medicine
Adamec, Ludwig W., Professor of Oriental Studies
Adamson, Lucile A., Assistant Professor of Chemistry
Adams, William G., Professor of Art
Adams, Hugh G., Assistant Professor of English
Ahmadi, Farshid, Assistant Professor of Internal Medicine
Aleks, Susan, Associate Professor of English
Albanese, Charles A., Professor of Architecture
Alberts, David S, Professor of Pharmacology and of Anatomy
Alcorn, Stanley, Professor of Plant Pathology
Aleamoni, Lawrence M., Professor of Educational Psychology
Alepa, F. Paul, Professor of Internal Medicine
Alexander, Mary A., Assistant Professor of Nursing
Allen, John D., Associate Professor of Language, Reading and Culture
Allen, Paul M., Professor Emeritus of Secondary Education
Allen, R. Van, Professor Emeritus of Elementary Education
Allen, Ronald E., Associate Professor of Animal Sciences and of Nutrition and Food Science
Allport, Rupert C, Professor Emeritus of Spanish and Portuguese
Allen, Ruth A., Professor Emerita of Home Economics
Altmann, Gene, Professor of Psychology
Altshul, D. Robert, Associate Professor of Geography and Regional Development
Akin, Frank, Assistant Professor of Economics
Ames, Wilbur S., Professor of Language, Reading and Culture
Ampt, Neil M., Assistant Professor of Internal Medicine
Amy, Gary, Associate Professor of Civil Engineering and Engineering Mechanics
Anders, Patricia L., Associate Professor of Language, Reading and Culture
Anderson, Kees, Associate Professor of English
Anderson, Karen S., Associate Professor of History
Anderson, Robert M, Associate Professor Emeritus of English
Anderson, Roger A., Professor Emeritus of Aerospace Engineering
Anderson, Woldo K., Professor Emeritus of Higher Education
Anderson, Warren H., Professor Emeritus of Art
Andrews, Arthur W., Professor of Law
Andrews, Gregory R., Associate Professor of Computer Science
Angel, J. Roger P., Professor of Astronomy and of Optical Sciences
Angiville, Jay B., Jr., Professor of Anatomy
Angus, Robert C, Professor of Agricultural Economics
Anooy, E., Professor of Philosophy
Anowitz, Lawrence M., Assistant Professor of Geosciences
Anthony, James R., Professor Emeritus of Music
Anthony, John W., Professor Emeritus of Geosciences
Antia, Shirin D., Associate Professor of Special Education and of Psychology
Antley, Elizabeth M., Professor of Teaching and Teacher Education
Aparicio, Francisco, Assistant Professor of Spanish and Portuguese
Aposhan, H. Vasken, Professor of Molecular and Cellular Biology and of Pharmacology
Appleton, Christopher P, Assistant Professor of Internal Medicine
Aquilano, Nicholas, Associate Professor of Management Information Systems
Argay, Ara, Assistant Professor of Aerospace and Mechanical Engineering
Arbas, Edmund A., Assistant Professor in the Neurosciences Division of the Arizona Research Laboratories
Archer, E., Professor Emerita of Psychology
Aren, Charles, Professor of Law
Ariew, Robert A., Associate Professor of French and Italian
Arnold, Harold S., Associate Professor of Psychology
Armstrong, Neal R., Associate Professor of Chemistry
Arnett, Peter F., Assistant Professor of Physics and of Astronomy
Arnold, Robert G., Assistant Professor of Civil Engineering and Engineering Mechanics
Ascher, Mark L., Professor of Law
Asia, Daniel I., Associate Professor of Music
Askin, Ronald G., Associate Professor of Systems and Industrial Engineering
Atkinson, George H., Professor of Chemistry and of Optical Sciences
Attarian, Peter J., Associate Professor of Family and Community Medicine; Assistant Professor of Psychiatry
Awuah, James E., Professor of Exercise and Sport Sciences
Awoodeh, Barbara A., Professor of Law
Axelrod, Harry R., Associate Professor Emeritus of Radiology
Baker, Robert L., Associate Professor of Systems and Industrial Engineering
Baker, Victor R., Professor of Geosciences, of Planetary Sciences and in the Lunar and Planetary Laboratory
Baker, Ronald C., Assistant Professor of Hydrology and Water Resources
Bals, Thomas R., Associate Professor of Aerospace and Mechanical Engineering
Barnard, Colin R., Associate Professor of Neurology
Barnett, Bryant, Professor of Dentrochronology in the Tree Ring Laboratory
Barbee, Robert A., Professor of Internal Medicine
Barefield, Russell M., Professor of Accounting
Barfield, Michael, Professor of Chemistry
Barker, Adele M., Associate Professor of Russian and Slavic Languages
Barlow, David L., Associate Professor of Agricultural Economics
Barnes, William D., Professor Emeritus of Secondary Education
Barnhart, Don H., Professor of Naval Science
Barreca, Robert A., Professor Emeritus of Radio and Television Production
Barrett, Bruce R., Professor of Physics
Barrett, Harrison H., Professor of Optical Sciences and of Astronomy
Barrett, William B., Professor of Accounting
Barrow, Leo L., Professor of Spanish and Portuguese
Barrows, Paul G., Professor of Plant Sciences
Barrat, Peter H., Professor of Optical Sciences and of Pathology
Barrett, Neil R., Professor Emeritus of Psychology
Battaglia, Frank J., Adjunct Professor of Agricultural Economics
Bashkin, Stanley, Professor of Physics
Baussan, Elena, Professor Emeritus of Anthropology
Bateman, Herman E., Professor Emeritus of History
Bates, Robert B., Professor of Chemistry
Baum, Eleanor E., Professor of Nursing
Bayles, Kathryn A., Associate Professor of Speech and Hearing Sciences
Bayly, Bruce J., Assistant Professor of Mathematics
Bechtel, Robert B., Professor of Philosophy
Beck, Jonathan, Professor of French and Italian
Becker, Stewart, Professor Emeritus of Electrical Engineering
Bedford, Felice L., Assistant Professor of Psychology
Bedrick, Alan D., Assistant Professor of Pediatrics
Beeker, Ruth Ann, Associate Professor of Elementary Education
Beigel, Allin, Professor of Psychiatry and of Psychology
Benjamin, James B., Assistant Professor of Surgery
Benson, Bryant, Professor of Anatomy
Benson, Clark T., Professor of Mathematics
Bergan, John R., Professor of Educational Psychology
Bergerson, Alan, Professor of Sociology
Bergstrom, Lisa A., Associate Professor of Dance
Berkhout, Carl T., Associate Professor of English
Bernath, Peter F., Assistant Professor of Chemistry
Bernard, Victor M., Professor of Surgery
Bernstein, Alan E., Associate Professor of History
Bernstein, Gail L., Associate Professor of Forensic Physics, and in the Institute of Atmospheric Sciences
Falco, Charles M., Professor of Physics and of Optical Sciences
Farnow, Marie D., Assistant Professor of Agricultural Economics
Fan, Chang-Yun, Professor of Physics
Fan, Paul, Assistant Professor of Mathematics
Fan, Paul, Assistant Professor of Music
Fangmeier, Dilmar D., Professor of Agricultural Engineering
Fars, William G., Professor of Mathematics
Farrel, Jim, Associate Professor of Naval Science
Farmer, Ian W., Professor of Mining and Geological Engineering
Farr, William M., Associate Professor of Nuclear and Energy Engineering
Fasei, Hermann, Assistant Professor of Aerospace and Mechanical Engineering
Fazio, Steve, Professor Emeritus of Plant Sciences
Fazzolaro, Rosalba, Associate Professor of Nuclear and Energy Engineering
Feinberg, Joel, Professor of Philosophy
Feinberg, William M., Assistant Professor of Neurology
Felix, William L., Jr., Professor of Accounting
Felmuth, Robert D., Professor of Chemistry
Fenster, Paul E., Associate Professor of Internal Medicine
Fenstermacher, Gary D., Professor of Education
Ferguson, Nancy E., Associate Professor of Music
Ferkelth, Sarah Lee, Associate Professor of Nursing
Fernandez, Celestino, Associate Professor of Sociology
Fernandez, Roberto M., Assistant Professor of Sociology
Fernando, Quintus, Professor of Chemistry, of Toxicology and of Forensic Sciences
Ferre, John R., Professor of Physics
Ferre, William R., Professor of Systems and Industrial Engineering
Ferris, Wayne R., Professor of Molecular and Cellular Biology
Ferry, Peggy C., Professor of Pediatrics and of Neurology
Follit, Peter F., Professor of Watershed Management
Fille, Paul C., Professor Emeritus of Mathematics
Finn, Jerrold, Professor of Psychology
Filippone, William L., Associate Professor of Nuclear and Energy Engineering
Fillerup, Joseph M., Professor of Teaching and Teacher Education
Finck, Ulrich, Professor in the Lunar and Planetary Laboratory and of Planetary Sciences
Fink, William H., Professor Emeritus of Economics
Finley, Paul R., Professor of Pathology
Firch, Robert S., Professor of Agricultural Economics
Fisher, Joseph G., Assistant Professor of Accounting
Fisher, Laura, Assistant Professor of Pharmacology
Fisher, Warner D., Professor Emeritus of Plant Sciences
Fitch, John R., Associate Professor of Music
Fitch, Walter S., Professor Emeritus of Astronomy
Fischbach, Hermann, Professor of Mathematics
Fleming, Robert J., Assistant Professor of Agricultural Engineering
Fleming, Margaret B., Associate Professor of Language, Reading and English
Fleming, Leslie A., Associate Professor of Oriental Studies and of Women's Studies
Flessa, Karl, Professor of Geosciences
Fligstein, Neil D., Associate Professor of Sociology
Flint, Franklin S., Professor of Architecture
Fippa, Edwin B., Professor of Banking and Policy
Flores, Carlos M., Assistant Professor of Pediatrics
Flores, Thomas V., Professor of Military Science Tactics
Forog, Martin V., Professor of Watershed Management
Foltz, Jack O., Associate Professor Emeritus of Accounting
Fordney, Diane S., Associate Professor of Obstetrics and Gynecology and of Psychiatry
Forster, Kenneth I., Professor of Psychology
Forster, Leslie S., Professor of Chemistry
Fortman, Marvin, Associate Professor of Management and Policy
Fox, Kenneth E., Associate Professor of Arid Lands
Foster, Robert E., Professor Emeritus of Plant Sciences
Fowler, H. Bruce, Assistant Professor of Media Arts
Foxman, Roger W., Assistant Professor of Agricultural Economics
Frank, Helmut J., Professor Emeritus of Economics
Frank, Milton, Assistant Professor of Psychiatry
Frank, Robert Wanda, Professor of Nursing
Franken, Peter, Professor of Optical Sciences and of Physics
Frankonis, George N., Assistant Professor of Civil Engineering and Engineering Mechanics
Freese, Ralph F., Assistant Professor of Exercise and Sport Science
Freer, Henry, Professor of Chemistry and in the Arizona Research Laboratories
French, Edward D., Associate Professor of Pharmacology
Frenzen, Jonathan K., Associate Professor of Marketing
Fritsch, Richard, Professor Emeritus of Soils, Water and Engineering
Frieden, B. Roy, Professor of Optical Science
Friedman, Richard, Professor Emeritus of Sociology
Friedman, Richard L., Assistant Professor of Microbiology and Immunology
Fritts, Harold C., Professor Emeritus of Dentrochronology in the Tree Ring Laboratory
Froehlich, Richard, Professor Emeritus of Soils, Water and Engineering
Fuchs, Esther, Associate Professor of Oriental Studies
Fudenberg, Wiliam V., Associate Professor of Language, Reading and Culture
Fujikawa, Vincent K., Professor of Pediatrics
Fulcher, Walter, Associate Professor of Soil and Water Science
Fung, Kee Y., Associate Professor of Aerospace and Mechanical Engineering
Gaines, Edwin M., Associate Professor Emeritus of History
Galbraith, Frederic W., Professor Emeritus of Geology
Galegher, Joline R., Assistant Professor of Management and Policy
Galgiani, John N., Associate Professor of Internal Medicine
Gall, Edward, Professor of Internal Medicine, of Surgery, and of Family and Community Medicine
Gall, Robert L., Professor of Atmospheric Sciences and of Geography
Gallagher, Kenneth F., Professor of Electrical and Computer Engineering
Gardner, Adel S., Professor of Oriental Studies
Garland, Wendy C., Associate Professor of Family and Consumer Resources
Garner, Allen W., Professor of Nuclear and Energy Engineering
Garfunkel, A., Joy, Associate Professor of Anesthesiology
Ganguly, Jambrima, Professor of Geosciences
Garica, John, Associate Professor of Political Science
Garica, Jose D., Professor of Physics
Garica, Juan R., Associate Professor of History
Garner, William S., Assistant Professor of Internal Medicine
Garner, M. Agnes, Assistant Professor Emeritus of Physical Education
Garrard, John, Professor of Russian and Slavic Languages
Garnett, Merril F., Professor of Psychology
Gaskill, Jack D., Professor of Optical Sciences and of Electrical and Computer Engineering
Gault, Robert H., Associate Professor Emeritus of Physical Education
Gaw, John R., Professor Emeritus of Secondary Education
Gay, David A., Associate Professor of Mathematics
Gaynep, John C., Professor Emeritus of Radiology
Gebhard, Albert F., Professor Emeritus of English
Gehrels, Anton M. J., Professor in the Lunar and Planetary Laboratory, Reading and English
Gehrels, George E., Assistant Professor of Geosciences
Gerfield, Mario M., Professor of Art
Georg, Josef, Assistant Professor of Management Information Systems
Ghale, Charles E., Associate Professor and of History
Gerber, Joseph S., Associate Professor Emeritus of Finance and Real Estate
Gerber, Rose M., Associate Professor of Nursing
Gerhard, Paul D., Professor Emeritus of Entomology and Zoology
Gergen, John W., Professor of Radiation Oncology and of Biochemistry
Giddy, Harry T., Professor Emeritus of Anthropology
Gibbons, James A., Professor Emeritus of Health, Physical Education and Recreation
Gibbs, J. Andrew, Professor of Electrical Engineering
Gibbs, Robert J., Associate Professor of Biochemistry and of Radiology
Gillies, Robert R., Professor of Oriental Studies and of History
Gipson, Rosemary, Associate Professor of Drama
Glass, Charles E., Assistant Professor of Mining and Metallurgy
Glass, Richard S., Professor of Chemistry
Glaser, Lewis, Professor of Pathology
Gring, Michael, Professor of Speech and Hearing Sciences and of Surgery
Green, Robert, Professor of Law
Green, Richard J., Associate Professor of Aerospace and Mechanical Engineering
Green, Arthur F., Associate Professor of Radiology
Green, Arthur F., Associate Professor of Political Science
Gren, Jeffrey F., Assistant Professor of Systems and Industrial Engineering
Goldberg, Stanley J., Professor of Pediatrics
Golden, Judith G., Associate Professor of Art
Goldman, Alan I., Professor of Philosophy
Goldman, Steven, Professor of Internal Medicine
Gold, Robert M., Associate Professor of Aerospace and Mechanical Engineering
Golzinger, Maryland, Associate Professor of Anatomy
Gosner, Kevin M., Assistant Professor of History
Gottlieb, Helen M., Associate Professor of Library Science
Gottfriedson, Michael R., Professor of Management and Policies, School of Public Administration and Policy, and of Psychology
Gould, Lauren M., Professor Emeritus of Geosciences
Gourley, Ronald, Professor of Architecture
Graham, Anna R., Associate Professor of Pathology
Graham, Gordon J., Professor of Agricultural Education
Granger, Byrd H., Professor Emeritus of English
Granth, Arthur T., Professor Emeritus of Higher Education
Granth, Robert T., Professor of Educational Foundations and Administration
Grant, Elizabeth A., Associate Professor of Dentrochronology
Graud, Robert C., Professor of Architecture
Green, Jerrold, Associate Professor of Oriental Studies and of Political Science
Green, Dennis, Associate Professor of Psychology
Greene, Dennis, Associate Professor of German
Greenlee, Wilfred M., Professor of Mathematics
Greene, Jennifer, Professor of Art
Greer, William F., Associate Professor of Journalism
Gretz, Karl C., Associate Professor of Spanish and Portuguese
Gregg, Robert B., Professor of Renewable Natural Resources
Grimes, William J., Professor of Biochemistry, of Molecular and Cellular Biology
Grissold, Ralph E., Professor of Computer Science
Gruenler, Helmut, Professor of Mathematics
Grogan, Thomas M., Associate Professor of Pathology
Gross, Joseph F., Professor of Chemical Engineering and of Chemistry
Gross, Maurice K., Professor Emeritus of Art
Grove, Larry C., Professor of Mathematics
Guerino, Ralph P., Professor of Psychology
Guerino, Vincent, Jr., Assistant Professor of Animal Sciences
Guertin, Philip, Assistant Professor of Watershed Management and of the Water Resources Research Center
Guider, John M., Professor of Geosciences
Guillo, Joseph D., Associate Professor Emeritus of Educational Psychology
Gulati, Uma, Associate Professor of History
Gyuro, Lanin A., Professor of Spanish and Portuguese
Hadley, Mac E., Professor of Anatomy, of Molecular and Cellular Biology and of Ecology and Evolutionary Biology
Haeterl, Lorraine C., Assistant Professor of Nursing
Haffner, Henry, Professor of Drama
Haime, Luc, Assistant Professor of Mathematics
Lieber, Daniel C., Assistant Professor of Pharmacology and Toxicology
Lightner, Elmer S., Professor of Pediatrics
Lindell, Thomas J., Associate Professor of Molecular and Cellular Biology
Lindsay, Everett H., Professor of Geosciences
Lindsey, Douglas, Professor of Surgery
Lilley, John C., Director of the School of Military Aerospace Studies
Littler, Charles A., Professor Emeritus of Art
Liu, Te-Lia, Professor Emeritus of Internal Medicine
Lloyd, Thomas R., Assistant Professor of Pediatrics
Lockard, W. Kirby, Professor of Architecture
Logan, Brian E., Associate Professor of Civil Engineering and Mechanics Engineering
Logan, James P., Professor of Management and Policy
Logan, Robert, Assistant Professor of Internal Medicine
Loehman, Timothy G., Professor of Exercise and Sport Sciences
Lomen, David O., Professor of Mathematics
Lomont, John S., Professor of Mathematics
Long, Austin, Associate Professor of Geosciences
Longacre, William A., Professor of Anthropology
Longstreth, Molly, Assistant Professor of Family and Consumer Sciences and of Agricultural Economics
Lopez, Patricia V., Associate Professor of Law
Ludovici, Peter, Professor Emeritus of Microbiology
Lullu, A. Paul, Associate Professor of Radiation Oncology
Lunine, Jonathan I., Assistant Professor of Planetary Sciences and in the Lunar and Planetary Laboratory
Lutz, Wendell R., Assistant Professor of Radiation Oncology and of Aerospace and Mechanical Engineering
Lutz, Babette, Associate Professor Emerita of German
Lynch, Dan, Professor of Materials Science and Engineering
Lynch, Lilian, Assistant Professor Emerita of Nursing
Lynn, Edward S., Professor Emeritus of Accounting
Lynn, Klondra, Professor Emerita of Speech
Lynn, Mary R., Assistant Professor of Nursing
Lyttle, Clifford M., Professor of Political Science
MacCorquodale, Patricia L., Associate Professor of Sociology
MacInnis, Deborah J., Assistant Professor of Marketing
MacKenzie, Neil E., Associate Professor of Pharmaceutical Sciences and in the Lunar and Planetary Laboratory
MacKinnon, William J., Professor Emeritus of Psychology
MacLennan, Angus, Professor of Optical Sciences and in the Arizona Research Laboratories
MacNeil, J. Douglas, Professor of Architecture
MacRitchie, Joseph, Professor of Mathematics
Maddock, Thomas III, Professor of Hydrology and Water Resources
Madison, Peter, Professor Emeritus of Psychology
Mahajan, Jayashree, Assistant Professor of Marketing
Mahalanobis, Abhijit, Assistant Professor of Electrical and Computer Engineering
Mahr, James M., Professor of Oriental Studies
Mahrer, Marion, Associate Professor of Drama
Mahl, Hannelore, Professor Emeritus of Physics
Mak, Joe, Professor of Russian and Slavic Languages
Maloney, John C., Associate Professor of Philosophy
Malwick, Alan J., Professor of Civil Engineering and Mechanics Engineering
Manber, Uri, Associate Professor of Computer Science
Manchanda, Sanjay, Assistant Professor of Computer Engineering
Mancino, Charles F., Assistant Professor of Plant Sciences
Mangelsdorf, Philip, Professor Emeritus of Journalism
Mann, Henry B., Professor Emeritus of Mathematics
Mann, Lance, Professor of Geography and Regional Development
Mannih, Robert W., Associate Professor of Wildlife and Fisheries Sciences
Manning, Doris E., Professor Emerita of Home Economics
Mansuripur, Masud, Associate Professor of Optical Sciences
Marathe, Arvind S., Professor of Optical Sciences
Marchalonis, John J., Professor of Microbiology and Immunology
Marchetti, Anna, Professor of Animal Sciences and of Nutrition and Food Science
Marcus, Frank I., Professor of Internal Medicine
Marchand, Paul A., Professor Emeritus of Veterinary Science
Marie, C. John, Professor of Veterinary Science
Martella, J. John, Associate Professor of Anatomy
Marion, Mary H., Associate Professor of Family and Consumer Sciences
Maron, Richard, Professor Emeritus of Drama
Marsh, Ozan, Professor of Music
Marshall, Robert H., Professor of Economics
Marshall, W. Edward, Professor of Media Arts
Marsten, Roy E., Professor of Management Information Systems
Marston, Jonathan B., Associate Professor of Geography and Regional Development
Martin, Arnold R., Professor of Medicinal Chemistry
Martin, Hollis K., Associate Professor Emeritus of Management
Martin, John W., Professor of Spanish and Portuguese
Martin, Paul S., Professor of Geosciences
Martin, S. Clark, Professor Emeritus of Range Management
Martin, William E., Professor of Agricultural Economics
Martinez, Oscar, Professor of History
Martinez, Rich, Associate Professor of Electrical and Computer Engineering
Martinson, Steven D., Associate Professor of German
Massey, William R., Professor Emeritus of Chemistry
Mason, Charles T., Professor of Ecology and Evolutionary Biology
Mason, Katherine M., Assistant Professor Emerita of Nursing
Mathieu, Deborah R., Assistant Professor of Political Science and of Philosophy
Mauldin, Neil D., Professor of Speech and Hearing Sciences and of Surgery
Maulock, William G., Professor Emeritus of Agricultural Engineering
Matsuda, Kaoru, Professor Emerita of Molecular and Cellular Biology
Matter, Fred S., Professor of Architecture
Matter, William J., Associate Professor of Wildlife and Fisheries Science
Matthias, Allan D., Assistant Professor of Soil and Water Science
Mattingly, Ateleia S., Professor Emerita of Speech Communication
Mellon, Roy H., Professor Emeritus of Electrical and Computer Engineering
Meier, Thomas A., Professor of Law
Maxwell, Margaret F., Professor of Library Science
May, Kathleen M., Assistant Professor of Nursing
May, Warren W., Professor of Mathematics
Mayersohn, Michael, Professor Emeritus of Pharmacological Sciences
Mazumdar, Sumitendra, Associate Professor of Physics
McAdam, Douglas J., Associate Professor of Sociology
McAllister, Christopher, Associate Professor of Economics
McBride, James C., Associate Professor of Economics
McEntire, Robert G., Professor Emeritus of Music
McCallum, William G., Assistant Professor of Mathematics
McCarty, Anne M., Professor of Special Education and Rehabilitation
McCaughley, William F., Professor of Nutrition and Food Science
McCaughey, William J., Professor Emeritus of General Biology
McCormick, Robert R., Assistant Professor of Range Management
McCord, Laura A., Assistant Professor of Psychology
McCone, Michael A., Professor of Plant Pathology
McCormick, Robert E., Professor of Agriculture
McCord, Beverly A., Professor of Nursing
McCormick, Floyd G., Professor of Agricultural Engineering
McCoy, Leahmae, Professor Emerita of Economics
McCoy, Thomas J., Assistant Professor of Plant Sciences
McCray, Betty J., Associate Professor Emerita of Nursing
McCullough, Edgar J., Jr., Professor of Geosciences
McCusker, Barbara J., Professor of Anatomy
McDaniel, Robert G., Professor Emeritus of Plant Sciences
McElroy, Donald M., Professor Emeritus of Aerospace and Mechanical Engineering
McElroy, David H., Associate Professor of Pathology
McElroy, Robert W., Professor Emeritus of Art
McElroy, John W., Jr., Assistant Professor of English
McElroy, John W., Jr., Professor of Philosophy
McGhee, Daniel L., Associate Professor of Radars and Remote Sensing
McGhee, Vann, Assistant Professor of Philosophy
McGinnis, William F., Professor of Pharmacy
McGinnis, William F., Professor Emeritus of Marketing and Accounting
McIntyre, Kenneth E., Assistant Professor of Surgery
McIntyre, Laurence C., Professor of Physiology
McKelvie, Douglas H., Associate Professor of Psychology
McKee, Carrol M., Associate Professor of Ma
McLaughlin, David W., Professor of Mathematics
McLaughlin, Steven P., Assistant Professor of Mathematics
McMahon, Jacqueline J., Assistant Professor of Teaching and Teacher Education
McManus, Robert W., Professor Emeritus of Art
McMillan, Terry L., Assistant Professor of English
McNamara, Donald J., Professor of Nutrition and Food Science
McNiece, Gerald M., Professor of English
McPherson, E. Gregory, Assistant Professor of Landscape Architecture
Mead, Albert R., Professor Emeritus of General Biology
Medina, Marcelo J., Jr., Assistant Professor of Educational Foundations and Administration
McElroy, John W., Jr., Professor of Philosophy
Medlin, Peter E., Associate Professor of English
Medlin, Richard L., Professor of Architecture
Meinel, Aiden B., Professor Emeritus of Optical Sciences and of Astronomy
Meisel, Wayne J., Professor of Microbiology and Immunology
Meisel, Harvey W., Professor of Surgery
Meiller, Robert, Associate Professor Emeritus of Ecology and Evolutionary Biology
Melnik, Alma, Professor of Language, Reading and Culture
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Melzer, Paul S., Assistant Professor of Pediatrics
Mendelson, Neil, Professor of Molecular and Cellular Biology
Mendez, Miguel S., Professor of Spanish and Portuguese
Mercado, Rodney M., Associate Professor of Music
Mering, John V., Professor of History
Merrill, Curtis B., Professor of Educational Psychology
Metcalf, Darrell S., Professor Emeritus of Agricultural Economics
Meyer, Michael C., Professor of History
Messtrie, Pierre, Professor of Optical Sciences
Miao, Ronald C., Associate Professor of Oriental Studies
Michod, Richard E., Professor of Ecology and Evolutionary Biology
Miesfeld, Roger L., Assistant Professor of Biochemistry and Molecular Biology
Milbacher, Hakan, Professor Emeritus of Civil Engineering and Engineering Mechanics
Miller, Allen E., Professor of Environmental Sciences
Miller, Donna M., Professor of Exercise and Sport Sciences
Miller, Glen M., Assistant Professor of Agricultural Education
Miller, James R., Associate Professor of English
Miller, Jerry L., Associate Professor of Sociology
Miller, Thomas P., Associate Professor of Interna
Miller, Thomas P., Associate Professor of English
Miller, Virginia J., Associate Professor Emerita of Nursing
Miller, Walter B., Professor Emeritus of General Biology
Millikin, William F., Associate Professor of Plant Sciences
Milsom, Ronald D., Professor of Philosophy
Milton, H. Brinton, Associate Professor of Management and Policy
Misaghi, Raj, Associate Professor of Plant Pathology
Mitchell, Donna M., Professor of Nursing
Mitchell, Shira P., Professor of Educational Psychology
Mitchell, Judy N., Associate Professor of Language and Reading Education
Moll, Luis C., Associate Professor of Language, Reading and Culture
Mom, Linda, Professor of Sociology
Momay, Navaine S., Professor of English
Monk, Eric L., Associate Professor of Agricultural Economics
Moons, Gerald, Professor of English
Montier, Leilani M., Associate Professor of Nuclear and Energy Sciences
Monty, Dewey E., Professor of Veterinary Science
Moon, John W., Jr., Assistant Professor of Pilates
ght, Stephen H., Associate Professor of Physiology
Yang, James C., Professor of Optical Sciences
Gansky, Israel J., Professor of Aerospace and Mechanical Engineering
more, A. Wayne, Professor Emeritus of Systems and Industrial Engineering
nn, Ruth E., Assistant Professor Emerita of Exercise and Sport Sciences
evitz, Sidney J., Professor of Systems and Industrial Engineering
kovsky, Samuel H., Professor of Pharmaceutical Sciences
Living, Professor Emeritus of Microbiology
mura, Henry I., Professor of Biochemistry, Pharmacology and in the Arizona Research Laboratories; Associate Professor of Psychiatry
spel A. Ralph, Professor Emeritus of Aerospace and Mechanical Engineering
et, Alayne, Professor of Psychiatry; Associate Professor of Pediatrics
Yeh, Tan-Chyi J., Assistant Professor of Hydrology and Water Resources
Yin, Yong-Guan, Assistant Professor of Mathematics
Yiayew, Muluneh, Assistant Professor of Agricultural Engineering
Youm, David E., Assistant Professor of Internal Medicine
Yoffer, Norman, Professor of Anthropology
Yoshino, I. Roger, Professor Emeritus of Sociology
Yost, Elizabeth B., Associate Professor of Psychology
Youmans, Robert L., Assistant Professor of Military Aerospace Studies
Young, Kenneth C., Associate Professor of Atmospheric Sciences and in the Institute of Atmospheric Physics
Young, Lai-Sang, Associate Professor of Mathematics
Younggren, Newell A., Professor Emeritus of Ecology and Evolutionary Biology
Zagona, Salvatore V., Professor Emeritus of Psychology
Zajac, Edward E., Professor of Economics
Zapolocky, Joseph A., Professor Emeritus of Pharmaceutical Sciences
Zegura, Stephen L., Associate Professor of Anthropology
Zehnder, Joseph A., Assistant Professor of Atmospheric Physics and of Atmospheric Sciences
Zegler, Bernard P., Professor of Electrical and Computer Engineering
Zeinisski, Brian J.J., Assistant Professor of Materials Science and Engineering
Zepeda, Ofelia, Assistant Professor of Linguistics
Zube, Ervin H., Professor of Renewable Natural Resources
Zukoski, Charles F., Professor of Surgery
Zumbro, Nicholas, Professor of Music
Zurbrick, Philip R., Professor of Agricultural Education
Zwinger, Lynda M., Assistant Professor of English
Zwolinski, Malcolm J., Professor of Watershed Management
GENERAL INFORMATION

The pursuit of truth and the extension of knowledge are well-recognized goals of most American universities. At the University of Arizona, the Graduate College is the major administrative unit through which these dual purposes are achieved. Building on a well-balanced undergraduate education, graduate students are expected to develop a thorough understanding of a specific academic discipline. The fundamental purpose of the Graduate College is to encourage each graduate student to demonstrate excellent standards of scholarship and to produce high quality, original research.

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

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

Accommodation of Religious Observance and Practice

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

Persons wishing clarification of the nature or proper application of this policy should consult the Office of the Dean 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.

The Agricultural Experiment Station (1890), one of the divisions of the College of Agriculture, is responsible for the basic and applied research programs in the schools, department and other units within the College of Agriculture. It is administered by the Director of the Experiment Station. Modern facilities for laboratory and field research and extension, as well as graduate and undergraduate teaching, are available on the university campus and at agricultural centers throughout the state of Arizona. Research is also conducted on farms, orchards, ranches, rangelands, and forests in cooperation with farmers and ranchers, and officials of various state and federal agencies.

Arizona Center for Educational Evaluation and Measurement (1980) initiates and conducts multidisciplinary research on such topics as nondiscriminatory psychological assessment; assessment of developmental competencies, sequencing of instruction, cognitive skills in children; and evaluation of school effectiveness. The center maintains state-of-the-art
search technology, prepares graduate students in research methodology; and provides technical assistance to public and private agencies regarding testing, student services, curriculum development and systems for program evaluation.

e Arizona Center for Mathematical Sciences (1988) has as its primary goal the mission of providing an environment for research and learning in the mathematical sciences. Its basic search themes are the modeling, understanding, and predictability of nonlinear processes in optics, fluids, neural networks, and random distributed systems with continuing inves- tigations into pattern dynamics, percolation, behavior of lattice gases, nonlinear stability, low dimensional chaos, turbulence, dynamical systems and the nature of integrable systems of differential equations. The center supports graduate students, sr doctoral fellows, long- and short-term visitors and sponsors various workshops throughout the year. These activities serve to provide an environment for student and faculty research.

10 Arizona Cooperative Fish and Wildlife Research Unit (1973) engages in graduate education, research, and extension. The unit is supported by the University of Arizona, the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute. The facilities and personnel of the unit are available to graduate students who wish to pursue both class work and research programs leading to advanced degrees in fisheries science and wildlife biology. The unit is housed in the School of Renewable Natural Resources.

11 Arizona Cooperative National Park Resources Study Unit (1973), located in the School of Renewable Natural Resources, is engaged in research to support the natural science program of the National Park Service. In cooperation with the University of Arizona, the unit provides graduate research opportunities and instructional support in a broad array of natural resource problem areas.

12 Arizona Heart Center (1986) is an interdisciplinary organization for research into cardiovascular biology and disease. The center's major objectives include conduct of basic and clinical research, provision of medical and surgical care to individuals, and provision of graduate, postgraduate, and continuing educational programs, both regionally and nationally. Coordination of cardiovascular research in the state and region is a major aim; close ties with investigators will be fostered. Research will include transplant immunology, echocardiography, clinical electrophysiology, molecular biology, experimental pharmacology and cell physiology, all applicable to cardiovascular problems.

The Arizona Heart Center operates as a division of the College of Medicine, reporting to the Dean of the College. Its programs are linked to faculty and staff in the college, in the University Medical Center, and in other colleges and units in the University.

13 Arizona Institute for Neurogenic Communication Disorders (1986) is a multidisciplinary academic unit designed to perform, coordinate, and administer research programs and a clinical center for speech and language disorders caused by diseases of the nervous system. Initiated by the Department of Speech and Hearing Sciences and the Department of Neurology, this unit includes the participation of cognitive science, exercise and sport sciences, linguistics, neuroscience, pediatrics, physiology, psychology, radiology, surgery, and systems and industrial engineering. In addition to its major thrusts involving research programs and a clinical center, the institute's mission includes fostering doctoral and postdoctoral education, state-of-the-art conferences, continuing education, and public service through advocacy for individuals with neurogenic communication disorders.

The Arizona Poison and Drug Information Center (1980) is operated by the College of Pharmacy and is located in the Arizona Health Sciences Center Library. The center provides comprehensive poison information and advice on treatment of poisoning to the public on a state-wide basis. It also offers drug information and therapeutic consultations to health professionals. The center has a toll-free telephone number (listed on the inside cover of Arizona telephone directories) and can be reached 24 hours a day, seven days a week. Full-time clinical pharmacists staff the center and serve as poison and drug information specialists. Serving as consultants are medical toxicologists and specialists in plant and animal poisons, drugs, and environmental and industrial poisons. The Arizona Poison and Drug Information Center also provides for clinical training of pharmacy students in the areas of drug and poison information. The Arizona Poison and Drug Information Center is a component of the Arizona Poison Control System which was established at the University of Arizona by the Arizona State Legislature in 1980. The Arizona Poison Control System is certified as a regional poison control program by the American Association of Poison Control Centers.

The Arizona Remote Sensing Center (1972) is the focus of remote sensing research in the College of Agriculture. The staff of the center is involved in interdisciplinary remote sensing and computer mapping projects related to agriculture and natural resource management. The center contains equipment for manual analysis of satellite and aircraft imagery and computer systems for digital processing and display of images and maps. These facilities are available to faculty, students and cooperators from outside the University.

The Arizona Research Laboratories (1979) is an interdisciplinary research unit established to provide a mechanism for administering and fostering research which bridges disciplines embraced by departments from more than one collegiate unit. A major thrust of the organization is to form research groups to initiate new programs of high priority to the development of the educational and research mission of the University. The organization of the laboratories also provides a mechanism for serving as an organized research component for those teaching and research units that do not have such a capability.

The Arizona State Museum, founded as a territorial museum in 1893, is an educational, research, and service division of the University. Museum exhibits emphasize prehistoric and recent Indian cultures of Arizona and the Southwest. Special temporary exhibits on a variety of subjects are presented throughout the year. The museum is open daily to the public. Closed major holidays.

The Arizona Transportation and Traffic Institute (1959) is engaged in broad research aimed at developing advanced methods of analysis and obtaining answers to the transportation problems in Arizona. Topics considered include the planning, design, and operation of transportation facilities, including pavement design and highway materials, as well as maintenance of these systems. The institute acts as a technical information center, and its activities are closely tied to those of the Department of Civil Engineering and Engineering Mechanics.

The Arizona Veterinary Diagnostic Laboratory, a section of the Department of Veterinary Science, is supported by a combination of state funds and user fees. Services are provided for livestock and companion animal owners, wild species, and other animals supervised by federal, state, and municipal
agencies, and include bacteriology, parasitology, virology, pathology and microbial water testing, and field investigations of range livestock problems referred by practicing veterinarians. Diagnostic faculty members participate in applied research studies involving disease problems of agricultural significance.

The Boyce Thompson Southwestern Arboretum (1927) is operated cooperatively by the University of Arizona (College of Agriculture), Arizona State Parks Board, and the Boyce Thompson Southwestern Arboretum Board. This public botanic garden has facilities for teaching and research. Situated on the edge of the low desert near Superior, Arizona, the arboretum is a two-hour drive from the campus. Thirty acres of native and introduced plants from arid and semi-arid regions, together with about 1,000 additional acres of undisturbed fauna and flora, are under arboretum control. Additionally, large tracts of relatively undisturbed habitats in a variety of biomes lie in the surrounding Tonto National Forest. Laboratory facilities and housing are available. The arboretum is open daily except for Christmas Day.

The Bureau of Applied Research in Anthropology (1952), a division of the Department of Anthropology, is a regional and international center for basic and applied research relating to the resolution of critical problems in human society: culture change, urban and rural living, technological innovation, social and cultural impact assessment, agricultural and institutional development, educational innovation, and research methods. As part of the University, BARA promotes interdisciplinary research efforts. Also, BARA actively involves students of anthropology in its on-going research projects.

The Bureau of Geology and Mineral Technology (1915) was reorganized by the state legislature, effective July 1, 1988, to form the Arizona Geological Survey as an independent state agency. The Arizona Geological Survey will replace the former Geologic Survey Branch of the bureau and will continue to serve as the primary source of geologic information in the state.

The mission of the Mineral Technology Branch will be maintained through the College of Engineering and Mines. Dissemination of information relating to mining, including health and mine safety and geological engineering, will be accomplished by the Department of Mining and Geological Engineering. Information about mineral processing and extractive metallurgy can be obtained from the Department of Materials Science and Engineering.

The Center for Computing and Information Technology (CCIT) provides campus-wide services and facilities in support of the instructional, research, and administrative computing needs of the University. The University's network of shared computers consists of a Control Data Corporation CYBER 175 computer, three VAX 11/780's, a VAX 11/750, a VAX 6700, and a VAX 8650 computer system in a cluster environment, an IBM 4381 and an IBM 3090 computer, one Prime computer system, and a Scientific Computer Systems (SCS-40) minicomputer. These computers are interconnected to allow data transfer between systems.

The CCIT provides a campus-wide data communications network supporting both central and distributed processors. Access to facilities is available 24 hours a day. Additionally, CCIT provides access to outside networks such as Bitnet and NSF NET, and to other major national supercomputer networks. Connections are available to the national supercomputer centers at Princeton, Cornell, Pittsburgh, Illinois, San Diego and NCAR. The CCIT provides terminal access centers at various locations on campus and dial-up access to the university systems.

The CCIT offers many services to assist users in taking advantage of available computing resources. Services include consulting on the use of the University's computers and various microcomputers; assistance in user acquisition of computing facilities; communications and networking between user owned equipment and the University's systems; computer facility planning and preparation; selection, acquisition, and installation of microcomputer hardware and software; mainframe and microcomputer training facilities; programming and applications services; and dissemination of information through user publications, manuals, and program library documentation.

The Center for Creative Photography (1975), a division of the University Library, is an internationally acclaimed research museum and study center devoted to the collections and archives of 20th-century photographers. Its collections include over 50,000 master prints, more than 500,000 study prints and negatives, correspondence, manuscripts, artifacts, and related documents. It contains a major research library of over 12,000 volumes and a rare book collection. The center sponsors a lecture series of internationally prominent photographers, historians, critics, and related scholars. The center has an extensive publishing program, which includes a journal entitled The Archive. This publication is available through subscription. Photographs and archive materials are available through both exhibition and personal print viewing appointments.

The Center for Middle Eastern Studies is engaged in a variety of aspects of research on the modern Middle East. It is the headquarters for the University's Egypt Working Group, which promotes research by experts in several disciplines. Other areas of research include Afghanistan, Iran, the Persian Gulf, Egypt, and the Fertile Crescent. One of only thirteen federally funded middle east centers in the country, this unit disseminates information about Middle East studies nationally and internationally. It also houses the Middle East Studies Association, which is the primary professional organization of scholars of the Middle East.

The Center for the Management of Information (CMI), The Center for the Management of Information, established through a grant from IBM, fosters programs designed to develop interdisciplinary approaches to the management of information. CMI activities have resulted in the development of a new integrated MBA curriculum that was implemented in the fall of 1986 and laboratories equipped with state-of-the-art technology at available for student use in support of management decision making in all MBA classes. In 1987 the Collaborative Management Room was opened as a facility for group planning, problem solving, and decision making, and research in these research areas has been established.

The Center for the Study of Complex Systems, a multi-disciplinary unit bringing together local and external researchers, is designed to identify and explore new concepts and features of complex nonlinear systems in various areas of science. Recent advances in the understanding of fundamental aspects of nonlinear systems, coupled with progress in computer technology, present new approaches to heretofore intractable scientific problems in diverse fields: climate; cognitive science; computational theory; elementary particle physics; evolutionary biology; materials and condensed matter science; motor control, robotics and prosthetics; neurobiology; vascular physiology; turbulence; and others. The center sponsors research, visiting scientists, workshops, and colloquia, aimed at encouraging the development of new approaches to complexity at the interfaces between traditional scientific disciplines such as biology, chemistry, mathematics, and physics.

The Center for the Study of Higher Education (1978) in the College of Education conducts research studies and provide
lateral service activities to meet state and institutional needs, as well as those of national, international and regional govern-
ment units and other organizations. It develops and dissemi-
nates information about higher education policy and operation and facilitates the research of faculty members and students. Social research and service projects are provided through diversity funds and outside support.

Cooperative Extension Service (1914) brings information about natural resources, family and consumer sciences, youth development (4-H), and community leadership and resource development. The service is financed from federal, state, and county appropriations. It operates through the county extension system, state and area specialist system with faculty trained in various specialties, and in the practical application of scientific information on farms, ranches and in rural and urban homes. Assistance is provided to target audiences in problem solving, formation dissemination and educational programs.

Division of Economic and Business Research (1949) is a research and service organization within the College of Business and Public Administration. Its broad objectives are to conduct research relating to business, economics, planning, and public policy; to complement the formal education of students through research experience; and to disseminate information. To achieve its objectives, DEBR builds and maintains regional econometric models for applications in forecasting and impact modeling, conducts research on state and local market conditions, analyzes the effects of public policy alternatives, and provides technical assistance for computerized corporate and government planning applications. It publishes the semi-annual Arizona Review, the monthly Arizona’s Economy, the chart book Arizona Economic Indicators, and the Arizona Statistical Abstract. It also produces forums and seminars for the public. In addition, DEBR answers requests from business, government, and the general public for tabular information and maps showing local demographic and business patterns and, as a member of the State Data Center, for computerized census information.

Division of Extended University and the Summer Session, as an academic division of the University, provides off-campus daytime and on- and off-campus evening credit courses as well as presession, summer session and winter session courses. Students desiring graduate credit for off-campus graduate-level courses offered through the division must first be admitted to the Graduate College on regular graduate status. Also, students desiring graduate credit should be certain that the particular section of the course for which the student intends to register has been authorized as available for graduate credit. Off-campus graduate courses carry university credit, which may be applied toward graduate degree programs where appropriate, but no student may later apply toward an advanced degree more than six units earned as a graduate nondegree student. (Please see the “Graduate Nondegree Status” section of this catalog.) Graduate students should confer with their advisors and the Graduate College regarding the applicability of extended university courses to their programs. Please see “Graduate Study in Summer Sessions” for information regarding summer study.

Division of Media Services (1939) provides a wide range of instructional media, production, research and public broadcasting services to the University, community and state. The division operates three maximum-power public broadcasting stations: KUAT-TV (Channel 6 and KUAS- Channel 27 in the Catalina Foothills), KUAT-AM (1550 kHz), and KUAT-FM (90.5 MHz and Translator Frequency, 89.7 MHz in northwest Tucson and Sierra Vista and 105.5 in Phoenix).

Professional production facilities are maintained in the Modern Languages Building, the Audiovisual Building and the Har- vill Building. Production capability includes color studio and television.

The stations are affiliated with Public Broadcasting Service (PBS), National Public Radio (NPR) and American Public Radio (APR).

The VideoCampus produces and distributes university courses to business and industry in the Tucson area through a two-channel interactive Educational Television System (IETS) and through the nation by videotape and live satellite transmission. See below for further information.

Instructional Production and Engineering provides high technology educational support including: (1) Pre-production and instructional design for video and audio. Production and post-production and distribution via nationwide Ku Band up-link facilities. ITFS and Microwave Transmission to Tucson and Fort Huachuca satellite reception facilities, large screen viewing facilities and teleconference facilities. (2) Videotaping for teaching assistant evaluations, meetings, conferences and seminars is available as well as satellite reception of Soviet and French television programs for use in foreign language classes, big screen television playback facilities for large class viewing and multi-image slide presentations for promotional and fund raising events. (3) Equipment maintenance and repair for departments is an additional service of Engineering and Production.

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

Division of Neurobiology (1985) of the Arizona Research Laboratories is an interdisciplinary research unit devoted to the neurobiology and behavior of insects. Investigations under way in the division, probing experimentally favorable insect neural preparations at the cellular, developmental, molecular, and systems levels, seek to reveal fundamental neurobiological processes and mechanisms common to many animal species including human beings. These studies also promise to advance our understanding of agriculturally and medically harmful insects.

The Economic Science Laboratory (1985) is a research unit of the College of Business and Public Administration. Its purpose is to support innovative research and instruction through the use of laboratory economics experiments. Recent areas of investigation include the performance of asset markets, comparative behavior of different auctions and forms of market organization, incentive systems in hierarchies, and comparative evaluation of processes for the provision of public goods, and the design of new exchange institutions to meet the information and technological demands of a wide variety of environments. ESL operates a computer laboratory dedicated to conducting economic, political, and business and government policy experiments. Other programs include lectures by visiting scholars, seed money for faculty and graduate student research, and organization of internationally attended conferences.

Engineering Experiment Station (1941) administers the funds of all sponsored grants and contracts of the faculty of the College of Engineering and Mines. Students are often supported by wages or work-study arrangements under individual projects. Using state-appropriated funds, the station promotes, initiates, and conducts engineering research of potential bene-

The Environmental Research Laboratory (1967) conducts research in controlled-environment agriculture (CEA) for intensive food production, in seawater crop irrigation, and in solar heating and cooling. ERL has designed CEA vegetable systems which produce crops in the desert sands of the United
States, Mexico and the Middle East, and it has developed CEA for the intensive culture of marine shrimp. ERL is developing halophytic crops for livestock feeds and other uses—plants which are irrigated solely with seawater or other highly saline water. ERL consults on such specie projects as the portrayal of agriculture of the future at the EPCOT Center at Walt Disney World in Florida. ERL has also developed a series of demonstration solar homes at Tucson International Airport, where the laboratory is located.

The Grace H. Flandrau Planetarium (1975), a part of the College of Arts and Sciences, was built as a result of a gift to the university by Grace H. Flandrau. It houses a 50-foot projection dome, a Minolta Series IV planetarium projector, and a hemispheric 35mm motion picture projector. It is used as a teaching facility for university classes in astronomy, and 25,000 Tucson public school children attend its special educational programs each year. The planetarium presents dramatic public programs on astronomy and planetary science that take audiences on cosmic journeys through time and space. The science exhibit halls and 16-inch telescope are open free to the public. Open daily except Mondays.

The Institute of Atmospheric Physics (1954) conducts research on the fundamental processes that are important in the study of weather, climate, and earth systems science. Particular emphasis is given to investigations in radiative transfer, remote sensing, atmospheric aerosols, atmospheric chemistry, cloud and precipitation physics, lightning and atmospheric electricity, atmospheric dynamics, mesoscale meteorology, and the mathematical modeling of global climate.

The Jeffrey M. Golding Clinical Research Unit (1984) is a specially equipped facility located in the College of Pharmacy. Its primary objective is to provide clinical scientists at the University of Arizona with the opportunity to study the action of drugs in humans with the ultimate goal of developing improved methods of treatment. The research unit has three rooms: a patient waiting room, a private office for conducting patient interviews or preliminary examinations, and the main room which houses two hospital beds and is equipped with specialized medical equipment.

The Karl Eller Center for the Study of the Private Market Economy (1983) is a research and education organization within the College of Business and Public Administration. It has three broad objectives: (1) to promote research processes, (2) to sponsor an Entrepreneurial Studies Program, and (3) to provide for business/academic exchange. Research is supported through the recruitment of Karl Eller Chair holders in the disciplines represented in the college. Faculty research fellowships are also available. The Entrepreneurial Studies Program offers both academic courses for students interested in entrepreneurship and practical courses on the development of business plans. Approximately 35 students are included in the program annually. Business/academic exchange occurs through an annual dialogue on significant national economic issues and through semiannual new venture forums where entrepreneurs discuss business plans.

The Laboratory of Tree-Ring Research (1937) is an outgrowth of the pioneering tree-ring studies initiated by Andrew Ellicott Douglass at the University of Arizona in 1906. A division of the College of Arts and Sciences, the Laboratory conducts a unique program of teaching and research in all aspects of dendrochronology. Graduate-level instruction is offered through cooperating academic departments, and a limited number of graduate research assistantships are available to qualified students. Current research efforts are directed toward the quantification of tree-ring parameters, the establishment of new tree-ring chronologies throughout the world, the understanding of basic tree growth and environmental relationships, the reconstruction of paleohydrologic, paleoclimatic, and paleoecological variables, and the documentation and development of prehistoric chronological controls. Along with the world's largest collection of tree-ring specimens from living trees in 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 (1960), the research institute associated with the Planetary Sciences Department, is housed in the Gerard P. Kuiper Space Sciences Building. Laboratory staff engage in research and graduate instruction in conjunction with the Planetary Sciences Department and frequently undertake projects in collaboration with other campus units as well, including the Departments of Astronomy, Geosciences, and Physics, and the Steward Observatory. Research programs at the Lunar and Planetary Laboratory are closely associated with the NASA space program and include numerous lunar and planetary missions. Several of the faculty of the department and the laboratory have been principal investigators 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 reflector 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 on Kitt Peak; and the multiple mirror telescope on Mt. Hopkins), a scanning electron microscope probe, a neutron activation analysis laboratory, a digital image processing laboratory, and the Space Imagery Center. The laboratory also maintains a state-of-the-art digital image processing laboratory. In addition, the laboratory conducts high altitude observational programs for solar, planetary, and stellar infrared spectroscopy using NASA jet aircraft. Research interests of the laboratory and department include experimental and theoretical geochemistry and cosmochemistry, lunar and planetary geology, spacecraft imaging of planetary surfaces, the physics of planetary interiors, cosmic rays, the sun and solar wind, astrophysical plasmas, polarimetry and studies associated with the origin of the solar system, infrared Fourier spectroscopy, planetary atmospheres, infrared astronomy, and astrometry.

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

The Mexican American Studies and Research Center engages in research, publication, public service, and undergraduate and graduate educational activities which enhance the study of the Mexican American experience and related issues. Major objectives of interdisciplinary research and publication include such areas as expressive culture, adaptations of the Mexican-born into U.S. society, educational practices and policies, minority entrepreneurship, and health care behavior and intervention strategies. Special research and service projects are provided through university funds and outside support. Funds of sponsored grants support training of students in a variety of disciplines. The center disseminates information of concern to the Hispanic community, sponsors lectures and forums and provides assistance to and linkage with the University and greater Mexican American community, as well as regional, national and international private and public sectors.

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

**clear 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 search problems in reactor engineering, including those of irradiation in core geometry, shielding, neutron behavior, transport characteristics, and control. The reactor operates at an average power level of 100 kilowatts with a thermal neutron flux of approximately 2 X 10¹³ neutrons per square centimeter per second. Operation in the pulse mode with peak power levels up to 680 Mw and pulse widths of about 17 milliseconds is also available.

The reactor is available for research to all departments of the university for neutron irradiation services. Objects of large size may be encased and lowered to the top of the reactor core for exposure to neutrons. Smaller samples may be placed directly in one of the forty thermal neutron exposure positions available. A pneumatic sample irradiation facility is available for research with short-lived radioactive materials, and external neutron beams may be used for neutron radiography. A variety of gamma ray spectroscopy equipment is available to follow the activation analysis.

**Office of Arid Lands Studies (1964),** administratively located within the College of Agriculture, is active in international studies, natural resources development and management, environmental studies, economic botany, new crop development, water and energy conservation, farming systems research, information services, remote sensing, geographic information systems, publications and education. Activities are conducted within the framework of the arid environment. The office provides interdisciplinary project management and works closely with local and campus communities as well as with local, state, federal, and international government agencies. The office administers the interdisciplinary Doctor of Philosophy degree with a major in arid lands resource sciences.

**The Optical Sciences Center (1967)** is a graduate center for research in applied and theoretical optical physics. Areas in which research is currently being conducted include electronics, image formation, image processing, laser physics, materials, medical optics, nonlinear optics, optical bistability, optical design, optical fabrication and testing, optical properties of materials, pattern recognition, quantum optics, remote sensing, spectroscopy, surface physics, and thin-film technology. Interdisciplinary programs in progress involve the departments of Astronomy, Chemistry, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Physics, and Radiology, as well as the Arizona Research Laboratory, the Optical Circuity Cooperative and the Optical Data Storage Center.

Special facilities of the Optical Sciences Center include CVD and vacuum-deposition thin-film facilities, dark rooms, an electronics shop, infrared laboratory, instrument shop, massive-optics shop, small-optics shop, student/faculty machine shop, and teaching laboratories. In addition, a multitude of computing facilities are available for use in both research and training programs.

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

**The SEMATECH Center of Excellence in Contamination/Defect Assessment and Control** is a national center for research in the area of integrated circuit contamination and defects occurring in semiconductor integrated circuit manufacture. The center was established in 1988 by SEMATECH, a consortium composed of U.S. companies engaged in the manufacture of integrated circuits and the U.S. Government. Goals of SEMATECH are related to improving the competitiveness of U.S. integrated circuit manufacturers in the international marketplace. The center is multidisciplinary, and has equipment for fine particle aerosol measurements, contamination analysis, and electrical measurement of integrated circuit test structures. Facilities are available to faculty, students, and personnel from SEMATECH member companies.

**The Social and Behavioral Sciences Research Institute** promotes fundamental and applied research focusing on both individuals and social groups. The areas of fundamental research encompass individual behavior, including its linguistic and psychological expression, social organization, theory and values, and public and private policy. Knowledge gained through the social and behavioral research is applied to the practical problems confronting society and the individual. This mission is achieved by stimulating and supporting the varied substantive research of faculty in the broad range of disciplines and interdisciplinary programs represented by the Faculty of the Social and Behavioral Sciences. Major departments and organized research units cooperate in establishing, maintaining, and operating the centralized research facilities of the institute. Primary among these is the SBSRI Data and Software Library which supplies technical support in computer software, and maintains an extensive data library. The SBSRI Survey Research Center is also a centralized facility providing survey design expertise (fee-based), computerized data entry equipment, and trained survey interviewers. It is designed to meet the needs of departments, organizations, and individual researchers who require the collection of data via the telephone survey. Cognitive Science, a research unit within SBSRI, coordinates research activity in linguistics, psychology and philosophy. It seeks to link theories of human mental capacities with experimental approaches, to discover the ways in which the brain carries out high-level mental functions, and to understand the nature of computation as it plays a role in the workings of the human mind. Laboratories designed for study of human perception and cognition and of experimental psycholinguistics support cognitive science research.

**The Southwest Center (1982)** is a unit of the Faculty of Social and Behavioral Sciences that fosters research, teaching, academic development, publication, and public programming on the history, culture, and development of the Greater Southwest (including northwestern Mexico). Associated with the center is the Bloom Southwest Jewish Archives, a national research center for Southwest pioneer Jewish history. Southwest Center initiatives are designed for their multiplier effects on the research and service mission of the University, creating new opportunities for interdisciplinary scholarship. As an agency dedicated to the enhancement of regional scholarship and intellectual service, the Southwest Center acts as a liaison to funding sources; creates and implements interdisciplinary regional research projects; pursues a vigorous publishing program; and engages in a broad range of public outreach and programming: conferences, seminars, lectures, speakers' bureau, cultural events. In partnership with the UA Press, the center publishes *Journal of the Southwest*, a scholarly regional quarterly, and sponsors the Southwest Center book series.
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 (1916) was established by the generous gift from Lavinia Steward, in honor of her husband, George Steward. For many years, the observatory's principal telescope was its 36-in. (91-cm) reflector, constructed with the aid of the Steward bequest. At this time, the primary research telescopes of the observatory include the Multiple Mirror Telescope (MMT), located on the Mt. Hopkins summit in the Santa Rita Mountains, the 90-in. (2.3-m) Ritchey-Chretien reflector at the Kitt Peak site, and the 61-in. (155-m) Cassegrain reflector found at the Mt. Bigelow station in the Santa Catalina Mountains. The MMT, operated jointly with the Smithsonian Astrophysical Observatory, represents an innovative and highly successful concept for construction of large optical telescopes; it has 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 northeast part of the University campus adjacent to the original 36-in. dome which now houses a 21-in. instructional telescope. The main areas of research at the observatory include extragalactic and galactic astronomy, with major 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 Radio-astronomy in Bonn, West Germany. The observatory's Large Mirror Lab is collaborating in the development of optics for the next generation of giant optical/infrared telescopes. The research programs also include a new initiative in theoretical astrophysics, and an active involvement in astronomy in space, such as the Infrared Astronomy Satellite (IRAS), Space Infrared Telescope Facility (SIRTF) and Space Telescope.

Located across North Cherry Avenue from Steward Observatory are the administrative offices and laboratories of the National Optical Astronomical Observatories. The two optical observatories and the National Radio Astronomy Observatory jointly sponsor a weekly series of professional colloquia. 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 Department of Physics and the Grace M. Flandrau Planetarium. In addition, close collaboration is maintained through Steward facilities shared by the Vatican Observatory, Smithsonian Astrophysical Observatory, and the National Radio Astronomy Observatory.

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

University Libraries. The University Library system contains more than 5,000,000 items, including books, periodicals, microforms, maps, government publications, manuscripts, and non-book media. Basic holdings cover all fields of instruction, and there are especially strong collections in anthropology, geology, and languages. The Southwest Institute for Research on Women (SIROW) 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 University Library system consists of the Main Library which houses the Central Reference Department, Government Documents, the Media Center, the Map Collection, and the Current Periodicals, Newspapers, and Microforms Room; the Science-Engineering Library; and the following Branch Libraries: the Oriental Studies Collection, the Music Collection, the Center for Creative Photography, the Southwest Folklore Center Special Collections, and the Library Science Library. Four large but separate library facilities are the College of Law Library, the Architecture Library, the Arizona Health Sciences Center Library, and the Arizona State Museum Library. In addition, several other departmental libraries such as the Division of Business and Economic Research Library, the Steward Observatory Library, the Herbarium, and the Lunar and Planetar Science Library have been established to serve special research needs.

Central Reference houses the library's main card catalog and reference materials for the social sciences, fine arts and humanities.

Government Documents is a regional depository for U.S. government documents; it houses almost a million items.

Media Center houses all the library's non-book material except microforms and music tapes and records.

Map Collection is a depository for USGS maps, and houses a fully cataloged collection of almost 200,000 maps on over 200 subject.

Current Periodicals, Newspapers, and Microforms display current issues of the 5200-plus periodicals received in the Main Library, subscribes to over 150 newspapers and has a collection of microforms which numbers nearly 2 million.

Science-Engineering Library houses all materials on science and technology; has over 360,000 volumes, over a million microforms, and displays current issues of its 4500-plus periodicals.

Music Collection houses the library's collection of 50,000 scores, 28,000 pieces of sheet music and 25,000 recordings. Facilities for listening are provided.

Center for Creative Photography houses the library's archival collection of over 100,000 works of 19th century photographers. The Center's collections are internationally known.

Southwest Folklore Center houses musical tapes and manuscript archives of Southwest music and folklore.
Library Science Library houses the library's collection of professional library literature in support of the Graduate School of Library Science.

Special Collections houses the library's collections of Arizona and Southwest Americana, special subject collections, rare books, fine printing, manuscripts, and the University of Arizona archives.

Oriental Studies Collection houses books, periodicals and newspapers in the Chinese, Japanese, Arabic, Persian, Hindi, Urdu, Turkish, and other Oriental languages; it has over 160,000 titles.

Law Library contains over 175,000 volumes, including the xerographic cases of all the jurisdictions in the United States and essentially all the English reported cases; American and English statutory law; decisions of federal administrative agencies; complete sets of leading legal periodicals; a carefully selected collection of legal encyclopedias, digests, treatises, and textbooks; and a developing collection of civil law with emphasis on Latin America.

Health Sciences Center Library is a specialized library, which serves the University Hospital as well as the Colleges of Medicine, Nursing, and Pharmacy, contains almost 150,000 cataloged volumes and receives approximately 3,100 serial titles. The collection includes books, journals, and nonprint materials for the health sciences.

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

The University of Arizona Museum of Art. The University of Arizona is exceptionally fortunate in that it possesses several outstanding art collections. Housed in our modern building are 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 sixteenth- and seventeenth-century art in the United States. Contemporary international painting and sculpture are well represented in the Edward Joseph Gallagher III Memorial Collection; 61 sketches and models by Jacques Lipchitz which comprise one of the largest collections of his work in the world; the C. Leonard Pfeiffer Collection includes notable paintings from the 1930s and was the first collection of art donated to the University. An active exhibition and educational program is available throughout the year. The Museum is open to the public on weekdays from nine to five and on Saturday from noon to four. There is no admission fee.

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

Art Department Print Collection. The Department of Art maintains and displays its own collection of original graphic arts, 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, woodcut and typography. Important donations by Mr. and Mrs. Kelley Rollig and Mr. and Mrs. Helen Murphy have given this collection a public importance which augments its original intent, that of a teaching collection for university art students.

The University of Arizona Poetry Center. A 1960 gift of Ruth Stephan, the rapidly growing poetry collection numbers more than 15,000 volumes of poetry; has an extensive collection of literary magazines and poetry readings on tape; and is available daily for use by students, faculty and the community. The collection includes poetry of all ages and various nations, with emphasis on American and British poets. It also includes books about poetry and poets. The center regularly sponsors campus readings by nationally known poets and writers throughout the year.

The University of Arizona Press (1959), a department of the University of Arizona, is a nonprofit publisher of regional and scholarly books. As a delegate of the University of Arizona to the larger world, the press publishes the work of scholars wherever they may be, concentrating upon scholarship that reflects the special strengths of the University of Arizona, Arizona State University, and Northern Arizona University.

The press publishes scholarly books in anthropology and archaeology, space sciences, and lands studies, biology, Latin American studies, Asian studies, American Indian studies, and other fields. Also on the UA Press list are trade books on the Southwest borderlands, including accounts by scholars and professional writers of the natural history, geography, history, folklore, and life-ways of the region. The UA Press does not publish children's books or volumes of original fiction or verse.

The University of Arizona Press invites inquiries from the authors of works—whether scholarly books or works of general interest—that are appropriate to its list.

Also appearing under the press imprint is the quarterly Journal of the Southwest, whose separate editorial and subscription office is in the UA Main Library.

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

The Water Resources Research Center (1965), an interdisciplinary organization is primarily devoted to assistance to water-related research activities at the three state universities. This assistance is in the form of federal Water Resources Research Act funds for research on water-related issues, providing access to water data and publications, bringing water research findings to the attention of potential users, and facilitating interdisciplinary research. The center is also 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.

Arizona-Sonora Desert Museum is a self-supporting, nonprofit institution situated fourteen miles west of the city of Tucson in a saguaro and palo verde landscape of the Sonoran desert. This
living indoor and outdoor museum of natural history enables one to gain in a few hours a knowledge of the flora and fauna of the Southwest that would otherwise require many years. Unique habitat groups and other displays of desert animals and plants have been developed at this unusual museum. The museum cooperates with educational institutions at all levels as an outdoor education center and provides laboratory and field space for research in the natural history of Arizona and Sonora, Mexico, with special emphasis on the Sonoran desert common to both states.

**Arizona Historical Society.** Organized in 1884 for "the collection and preservation of materials illustrative of the history of Arizona in particular and of the West generally," the Society receives support from the state, and maintains both a historical museum and a research library. The museum and library are located adjoining the University campus and contain 50,000 books, 2,000 manuscript collections, and 250,000 photographs. The manuscript collections are especially rich, with letters, diaries, journals, business records and other documents, many of which are still partially or completely unpublished. One of its most valuable research resources is its file of over 2,000 bound volumes of Arizona newspapers beginning with the first issue of the first weekly in 1859. State and federal historical records are on microfilm, as are records from Spanish colonial archives. Membership is open to everyone.

**The Museum of Northern Arizona** and its Research Center, located at Flagstaff, Arizona, provide unusually fine training and research facilities in many areas of anthropology, art, biological sciences, and geology. A close association is maintained between the staff of the Museum and Research Center and certain teaching and research departments of the University of Arizona. Field work and independent research for a limited number of graduate students can be undertaken at the Museum's Research Center with the approval of the departments concerned, the Director of the Museum, and the Dean of the Graduate College. Registration may be arranged by the procedure commonly used for work done in absentia for credit in 900 Research to apply toward requirements for an advanced degree, for 910 Thesis, and for 920 Dissertation.

**The Southwestern Research Station** of the American Museum of Natural History, New York, is located within a few hours of the University campus in the Chiricahua Mountains of southeastern Arizona. The station proper is located at an elevation of 5,400 feet in a moderate evergreen woodland climate, midway between the desert below and the coniferous forest above. A wide variety of life zones is represented within a few miles of the station between the desert floor and the fir-covered peaks at 9,800 feet. This unspoiled area within the Coronado National Forest includes many protected wilderness areas accessible only on foot or horseback.

Station living facilities and equipment are available, and the laboratory is well equipped for many kinds of modern field and laboratory research in ecology and physiology. The station is a field base for almost any kind of field work in biology, geology, paleontology, resource management, and wildlife management.

**United States Government Agencies.** A number of agencies of the United States Government, including several divisions of the Agricultural Research Service and the Soil Conservation Service of the United States Department of Agriculture, the United States Bureau of Mines, and the United States Geological Survey, are located on or near the campus of the University. These research organizations work closely with the University, and a number of their personnel also hold university staff appointments.

**Fees—1989-1990**

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

**Legal Residents of Arizona:**

- Registration fee .................. $1,362.
- Residence halls, average rate** $1,400.
- Meals in university cafeteria ...... $1,792.
- Books and supplies ................ $550.
- Total minimum annual expense .... $5104.

**Nonresidents of Arizona:**

- Registration fee .................. $1,362.
- Nonresident tuition fee*** ......... ($681.00 per semester
- Residence halls, average rate** $1,400.
- Meals in university cafeteria ...... $1,792.
- Caps and gowns ................... $14.50.
- Books and supplies ................ $550.
- Total minimum annual expense .... $9226.

**Miscellaneous Expenses**

- Application fees to graduate degree program .... $25.0
- to graduate nondegree status ....... $10.0
- for readmission ................... $10.0
- Music fee for private lessons, per semester*** $40.0
  1/2 hr. per week ................... $40.0
  1 hr. per week ................... $60.0

See General Catalog for further details.

**Late registration fee (any period)** .... $10.0

- Foreign student language examination fee...
  (any one examination) ............ $10.0
- Application fee for degree candidacy . $10.0
- Processing fee (thesis or dissertation) $15.0
- Dissertation microfilm fee .......... $25.0
- Caps and gowns are purchased for $15.0 or $18.50, depending upon degree. Hoods are purchased for $14.50 or $17.00, depending upon degree.

**Transcript fee** ................... $1.0

(Instantaneous service is $4.00)

**Housing**

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

**Married Students and Single-Parent Families**—The University has 420 apartments, located about six miles from the campus available for qualified married students and single-parent families. Interested students should write directly to the Department of Residence Life, 3401 North Columbus Boulevard, Tucson, Arizona 85712 for additional information.
University offers a variety of dining services operated in the Union and in the Garden Court Restaurant at the Park Center. The range includes specialty snack bars, cafeterias, and a complete table-service restaurant. Campus dining locations are also offered. All Aboard is the university plan that is available to all students. For additional information, write: All Aboard, S.U.P.O. 10,000, Tucson, AZ 85720. Approximate monthly food cost for the average student is $300.00.

Counseling, testing, job and learning skill services are available to students through the Student Resource Center in the Old Main Building; the Student Health Service (Infirmary); the Speech and Hearing Clinic; the Disabled Student Services Program (individualized support group services); the Foreign Student Advisor; the American Indian Student Advisor; and the Veterans' office. For full information concerning each of these, the student should consult the Dean of Students Office or the General Catalog.
GENERAL REGULATIONS

The Nature of Graduate Work

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

Admission

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

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

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

Grade-Point Average

Applicants who apply for admission to the Graduate College are evaluated on the individual merits of their academic achievements and individual scholarly potential to complete graduate level course work and curriculum requirements. Ordinarily, a minimum cumulative grade-point average of 3.0 over the last 60 units or a minimum cumulative grade-point average of 3.0 over a minimum of 12 hours graduate course work is required for admission to the Graduate College. Applicants should consult the academic unit to which they are applying regarding that unit's grade-point average expectations. Prospective students who do not meet this standard may enroll as nondegree students and complete 12 credits of 500-level (or higher) course work with a grade-point average of at least 3.25 in order to establish eligibility seeking admission to the graduate degree program of their choice.


**Proficiency in English**

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

**Admission of Foreign Students**

Nonimmigrants should request graduate application forms from the Graduate Student Admissions Office and departmental requirements and materials from the major department. All foreign student applications, with the required credentials, should reach the Graduate Student Admissions Office before March 1 for the summer and fall terms and September 1 for the spring term. Some graduates of foreign institutions may be admitted initially as International Special Students for a period of enrollment limited to two academic terms with the understanding that they may be required to undertake some work without graduate credit in order to make up deficiencies in preparation. In any event, no commitment can be made regarding the time required to complete a course of study.

**International Special Status**

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

**Proficiency in English**

University requires all applicants whose native language is other than English to take the Test of English as a Foreign Language (TOEFL) unless they have completed at least two academic years of full-time study or received a bachelor's or higher degree at a postsecondary academic institution in which English is the spoken tongue and medium of instruction. Results of the TOEFL are valid for two years to the semester of first attendance, 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 the examination must be received before the student's application is complete. New students who are required to take the TOEFL and whose scores are below 550 are required to take a locally administered English test and to enroll for any further English courses which may be required by the Graduate College or by the student's department. Students whose native language is not English and who wish to be considered for a teaching assistantship must also submit scores on the Test of Spoken English (TSE) that is also administered by the Educa-
ional Testing Service of Princeton, New Jersey 08540, or the SPEAK test available at the University of Arizona.

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

Financial Resources for Foreign Students

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

Application for Admission

Application for admission to the Graduate College must be made on forms furnished by the Graduate College. Completed application forms must arrive before supporting transcripts come or processing can be seriously delayed. An applicant from another institution should request that one set of complete official transcripts of all undergraduate and graduate work done and degrees received be sent directly by the institution at which the work was done to the Dean of the Graduate College of the University of Arizona. Credits which appear as transfer credit on any other transcript are not valid; applicants must submit an official transcript from the school where the credits were earned. Both the application and the transcripts should be on file four to six months prior to registration. Applicants whose records are not in English are required to provide a certified translation of their records. Applicants should also contact the department of their intended major to obtain departmental application materials and requirements. Students who have been admitted to the Graduate College but who were not enrolled during the previous regular semester must reapply for admission. (See “Admission for Part of an Academic Year” for exception to this policy.) All material becomes the property of the Graduate College and will not be returned.

Candidacy for an Advanced Degree

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

Students in master's programs apply for candidacy by submitting the Master's Degree Study Program, with appropriate signatures, to the Graduate College. Students in doctoral programs submit the Application for Candidacy. Upon approval the appropriate form by the Dean of the Graduate College, the student is admitted to candidacy.

Graduate Credit for Seniors

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 advisor. The Dean will not approve a petition unless the senior has a grade-point average of 3.000 or better on all work already completed at the University, is proceeding toward graduation as directly as possible, and does not propose a total load to exceed sixteen units. The maximum number of units of graduate credit that may be earned by a senior in any semester is equal to the difference between sixteen and the number necessary to complete requirements for graduation.

General Prerequisites for Major Graduate Credit

The undergraduate major, or its equivalent, in any field of study is prerequisite to major graduate work in that field. In some cases, a field of concentration in undergraduate work different but suitably related to the graduate major may be acceptable. Deficiencies in undergraduate preparation must be satisfied by the completion of prescribed courses, for undergraduate credit.

Regular Graduate Credit Courses

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

Use of 400-Level Courses in Graduate Programs

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

Transfer of Graduate Credit

The University of Arizona accepts graduate credit by transfer from other accredited institutions; however, the whole number of transferred units offered toward a master's degree may not exceed twenty percent of the minimum number of units required for the degree in question. Such transfer of credit may be applied toward an advanced degree only upon satisfaction of such additional courses as may be prescribed by the head of the corresponding department in the University. In any case, transfer of credit toward an advanced degree will not be made unless approved by the head of the major department, unless the grade earned was A or B, and unless it was awarded graduate credit at the institution where the work was completed. Furthermore, transfer will be made of credit only; no account will be taken of the grades of transfer work in computing the student's grade point average. Such transfer
ich must be arranged by the student through the Graduate
the Graduate System, may be initiated at any time but will not
come effective until the student has completed satisfactorily
least twelve units of graduate work at the University of Ar-
zona.
Credit for extension work from other institutions will not be
accepted. A student who plans to complete the final semester of the
graduate program at another institution and to transfer those
its to the graduate degree at the University of Arizona should
be aware that delays in obtaining official transcripts from the
other institution may result in postponing completion of degree
requirements by at least one semester.

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

Graduation System
The grading system used by the University of Arizona follows:

A - Excellent
B - Good
C - Fair
D - Poor
E - Failure
P - Passing (see section on "Pass-Fail Option")
F - Failure (see section on "Pass-Fail Option")
S - Superior (see paragraph on "Special Grades")
I - Incomplete
K - Course in progress
W - Approved withdrawal
O - Audit
CR - Credit

Examinations Required
Examinations offered for credit shall include a final examination
within the regularly scheduled examination time, unless spec-
ic exceptions for certain courses have been granted prior
approval by departmental action and have been reported to
the appropriate academic dean.

Withdrawal Grades
Withdrawal Grades are allowed 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. The grade of W shall not be awarded to graduate
students after the last day of the tenth
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 num-
ered 591, 593, 594, 599, 691, 693, 694, 699, 791, 793, 794,
900, 906, 909, 910, 915, 920, and 925. The only grades avail-
able 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
16, the instructor may use these special grades or the regular
ter grades as departmental policy or the instructor’s own
policy dictates; but all registrants in a given instance are
ated by the same system. Grades available for 900 are S, P,
D, E, K, and W. The only grades available for 908, 909, 910,
915, 920, and 925 are S, P, E, K, and W. The only grade avail-
able 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
Graduate students cannot enroll in graduate level courses for
pass/fail grading. Graduate students may enroll for pass/fail
grading in nondeficiency courses for which a pass/fail option
already exists and for which graduate credit is not available.
Also, graduate students may enroll for pass/fail grading in any
course offered by the College of Law.

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

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

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

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

Each student admitted to a graduate degree program who, during any academic term, is associated with the University in any capacity that makes use of University facilities or faculty time must register. During the fall and spring semesters, a minimum of three units of graduate credit will be required; during any summer term, one unit of graduate credit will be required. The minimum course work registration requirement may be met by registering officially for any single course or a combination of courses for which the total number of units meets or exceeds the specific minimum.

Supplementary Registration

Each student completing requirements for an advanced degree must be registered during the semester or summer term during which requirements are completed, or the previous semester or term if requirements are completed during an intersession. Students who have previously enrolled for all the regular courses required for their degrees and who still must register should enroll for supplementary registration (course number 930). Supplementary registration may be used concurrently with other enrollments to meet these registration requirements.

Thesis and Dissertation Work in Absentia

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

Auditing of Courses by Graduate Students

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

Graduate Study in Summer Sessions

Graduate study is available during the University of Arizona summer sessions. All courses numbered at the 500, 600, 700, or 800 levels are graduate courses. In response to demand for graduate work during the summer, a number of departments of the University have provided for individual research in their special fields. Such courses are listed under their respective departments. Students who wish to pursue any of these courses must obtain the consent of the course instructors before registering.

Graduate credit earned at the University of Arizona Summer School at Guadalajara, Mexico, may be used directly in advanced degree programs where appropriate. In certain departments provision is made for teachers in service and others who are unable to attend the University during the regular year to complete the requirements for the master's degree by attendance at summer sessions only.

Expenses—Tuition per unit of credit for the 1989-90 academic year is $71.00. There is no additional nonresident fee for out-of-state students. In addition to the per unit tuition fee, students are assessed a student fee of $5.50 per unit. Since fees are subject to change, students should consult the current Summer Session Schedule of Classes for fees in effect for any given year.

Graduate Appointments, Scholarships and Financial Aids

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

Students are also urged to explore various other possibilities at other locations such as the student's major department; the College of Education; the Advisor to Study Abroad; the Study Counseling Service; and the Social Science Reference Department of the Main Library.

Assistantships and Associateships

Teaching and research assistantships are available in many University departments. Approximately 2,200 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 $2,644 to $4,242 for services not exceeding ten hours a week, or $5,289 to $8,494 for half-time assistantships.

Tuition and Fees—Graduate assistants and associates are exempt from the nonresident tuition charge and from most fees applicable to courses in their major fields. Registratic 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 the appointments.

Maximum Enrollment—The maximum number of units per semester which students employed as graduate assistants or 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.

Scholarships, Fellowships, Traineeships, Grants, Awards

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

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

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

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

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

Also available are funds from the Minority Graduate Student Development Fund and the Minority Graduate Student Travel Fund. These two sources of assistance help students cover costs associated with thesis and dissertation research and travel to professional meetings to present their research findings. Minority graduate students in good academic standing are eligible to apply for these funds through the Graduate College.

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

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

**Loans**

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

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

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

Major Fields for Master's Degrees

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

accounting  creative writing
aerospace engineering dairy science
tagricultural economics dietetics
agricultural education drama
agricultural engineering ecology & evolutionary
agronomy & plant genetics biology
classics economics
American Indian studies educational administration
anatomy* educational media
animal sciences educational psychology
anthropology electrical engineering
applied mathematics elementary education
architecture engineering mechanics
art English
art history English as a second
architecture language
art education entomology
art history exercise and sport sciences
astronomy family and consumer
botany resources
business administration finance
cancer biology food science
chemical engineering foundations of education
chemistry general biology
civil engineering genetics
classics geography
communication geological engineering
communication general biology
counseling & guidance geosciences
creative writing German

dairy science health education
dietetics higher education
drama

ecology & evolutionary linguistics
biology management and policy
business administration management information
comparative literature & literary systems
composition (music) marketing
computer science materials science &
comparative literature & literary engineering
composition (music) mathematics
computer science mechanical engineering
comparative literature & literary music education
composition (music) music theory
comparative literature & literary musicology
comparative literature & literary neuroscience
comparative literature & literary nuclear engineering
comparative literature & literary nursing
comparative literature & literary nutritional sciences
comparative literature & literary optical sciences
comparative literature & literary Oriental studies
comparative literature & literary performance (music)
comparative literature & literary pharmaceutical sciences
comparative literature & literary pharmacology

*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
- 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 a Doctor of Philosophy.)

- Agronomy & plant genetics
- Anatomy
- Applied mathematics
- Geodetic sciences
- Geology
- History
- Horticulture
- Music
- Musicology & evolutionary biology
- Neurosciences
- Educational administration
- Educational psychology
- Electrical engineering
- Elementary education
- Engineering mechanics
- English
- English education
- Geology

Performance (music/A.Mus.D.)
- Pharmaceutical sciences
- Pharmacology and toxicology
- Philosophy
- Physics
- Planetary sciences
- Political science
- Psychology
- Range management
- Reading
- Rehabilitation

- family and consumer resources
- Foundations of education
- French
- Genetics
- Geography
- Geosciences
- Higher education
- History
- Horticulture
- Hydrology
- Irrigation engineering
- Linguistics
- Materials science & engineering
- Mathematics
- Mechanical engineering
- Microbiology & immunology
- Mineral economics
- Mining engineering
- Molecular & cellular biology
- Music education
- Music theory
- Neuroscience
- Nuclear engineering
- Nursing
- Nutritional sciences
- Optical sciences
- Oriental studies

Advanced Degrees Offered

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

- Master of Accounting (M.Ac.)
- Master of Agricultural Education (M.Ag.Ed.)
- Master of Architecture (M.Arch.)
- Master of Arts (M.A.)
- Master of Business Administration (M.B.A.)
- Master of Community Education (M.C.E.)
- Master of Developmental Education (M.Dev.Ed.)
- Master of Educational Administration (M.Ed.)
- Master of Fine Arts (M.F.A.)
- Master of Home Economics Education (M.H.E.Ed.)
- 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.)
- Educational Specialist (Ed.S.)
- Nursing Specialist (N.S.)
- Specialist in Microbiology (Sp.M.)
- Doctor of Education (Ed.D.)
- Doctor of Musical Arts (A.Mus.D.)
- 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 "Certification for Community College Teaching" in the College of Education section, General Catalog.
REQUIREMENTS FOR MASTER’S DEGREES

General Requirements

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

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

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

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

Master's 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 advisor and the department head 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 requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level above, university-credit courses, and that at least one half the required units be offered in courses in which regular grades (A, B, C) have been earned. Approval 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. An appropriate departmental statement in this catalog will indicate the thesis requirements for each degree. Where a thesis forms part of the program, a limited number of units may be earned for preparation. Following the final examination, the candidate submits to the Graduate College for review a final copy of the completed thesis (approved and accepted by the major department), along with the Statement by Author and specific abstract of 150 words or less. After making any required corrections, the candidate submits two complete and signed copies of the thesis to the Graduate College on or before the date specified in the Graduate Calendar for the candidate's degree award date. 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.
cation of Thesis—Master's theses are published by Uni-
y Microfilms, Ann Arbor, Michigan. Upon certification by
the student’s major professor, members of the committee for
nal examination, and the Graduate College, a thesis copy
an abstract of 150 words or less are forwarded to Univer-
icrofilms. (This abstract is in addition to the two abstracts
red for processing with the thesis and must be carefully
ed and the negative inspected and put in vault storage; the
g information is sent to the Library of Congress for print-
d distribution of cards for depository catalogs and library.
The abstract is printed in Microfilm Abstracts and
uted to leading libraries in the United States and abroad,
 to a selected list of journals and abstracting services. The
is then returned to the University of Arizona Library.
blication by microfilm does not preclude publication by
 methods later, and successful candidates are urged to
thesis material for publication in a scholarly or profes-
s journal. Suitable acknowledgment must always indicate
publication to be a thesis, or portion of a thesis, submitted
tral fulfillment of the requirements for a master's degree at
University of Arizona.

Examination—A candidate for the master’s degree must
 a final examination, oral or written or both, administered
committee of at least three faculty members (including at
 two from the major department) recommended by the
 department for appointment by the Dean of the Graduate
age. The result of the examination must be reported to the
uate College within two weeks. Any candidate who fails
inal examination may, upon recommendation of the major
ment and approval of the Graduate Council, be granted
ond examination after a lapse of at least one semester.
second examination is final. The report of successful com-
on of all requirements must be made to the Graduate Col-
at least 21 days before the date on which degrees are
ed.

Second Master’s Degree—Normally, students may earn only
master's degree at the University of Arizona. Occasionally,
ent is permitted to enter a second master’s degree pro-
 if the majors are sufficiently different to justify such an
ition. No student will be permitted to undertake a third
er’s degree program at the University without the specific
approval of the Graduate Council.

Master of Arts and Master of Science

inimum of thirty units of graduate work, including the thesis
one is appropriate, is required. Not less than fifteen units
be in a major field. By prior approval of the Graduate
ncil, two or more closely allied subjects may be combined
m a major. Special departmental requirements, if any, are
 in departmental headnotes.

Master of Accounting

Master of Accounting degree program is a graduate pro-
ional program designed to provide advanced specialized
ing in accounting and related fields. Except as indicated
, the general regulations and requirements for the Master
ience degree apply.

score at the 60th percentile or above on the Graduate
agement Admissions Test and an academic average of
approximately "B" or better are required for admission consid-
ation. Applicants must also have completed 6 hours of statis-
is and 24 hours of accounting including: accounting
icles, 6 hours; intermediate accounting, 6 hours; cost
unting, 3 hours; federal income tax, 3 hours; advanced
unting, 3 hours; and auditing, 3 hours.

Of the 30 hours required for the Master of Accounting
degree, no fewer than 15 must be in the field of accounting and
at least 16 must be in course work open only to graduate
ents. The required courses consist of a 15-hour core: Acct. 510,
526, 528, 531, and 569. The balance of the 30 hours is to be
pleted with electives. Each candidate must pass a written
prehensive examination.

Master of Agricultural Education and Master of Home
 Economics Education

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

Master of Architecture

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

For admission consideration, applicants must have com-
pleted, 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 under-
graduate 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 accumu-
late one year of professional work experience prior to undertak-
ing 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 exam-
ination 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 vari-
ety 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. Under-
graduate courses in finite mathematics calculus are prerequisites and should be completed prior to entering the program. If the math deficiencies are not eliminated before beginning course work, students must enroll in M.I.S. 400 (a fast-paced finite math and calculus course) during the first semester.

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

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

The M.B.A. curriculum emphasizes an integrative approach to problem solving. There are 24 units of comprehensive functional core courses, 15 units of integrative course work, and 18 units of specialization electives, for a total of 57 required units for the degree. Students with prior academic training equivalent to required core course work (with the exception of M.A.P. 500) may petition the program administrator for a waiver up to, but not exceeding, 15 units.

Full-time students completing the program in four academic semesters enroll in course work in the following sequence:

First semester (Fall):
- Total units = 15.

Second semester (Spring):

Third semester (Fall):
- Acct./Fin. 569 (3), Econ./M.A.P./Mktg. 568 (3), Specialization Electives (9). Total units = 15.

Fourth semester (Spring):
- M.A.P. 571 (3); Specialization Electives (9). Total units = 12.

Students may elect a specialization in auditing, managerial accounting, entrepreneurial, financial markets and investment analysis, financial institutions, health care management, human resource management, operations management, systems analysis and design, telecommunications, or marketing management, or may select courses and seminars from the approved list of general studies courses.

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, educational administration, educational media, educational psychology, elementary education, foundations of education, higher education, reading, secondary education, and special education.

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

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

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 by the applicant's undergraduate major differs significantly from the corresponding major at the University of Arizona. These are not required but the departments reserve the right to require departmental collections of a selected work, or works, for those submitted in connection with students' work toward degree. Final examinations are required. Applicants should contact the appropriate department and ask for instructions about submitting examples of creative work directly to the department in support of an application. Special features and requirements of the three programs are described below.

Major in Art

Applicants must submit slides of their studio work (or in the case of the photography program applicants, original photographs) directly to the Department of Art. All other application materials, including transcripts, are to be sent to the Graduate College. No application will be considered until slides or photographs, transcripts, and application forms have been received. The requirements are the same as those for the degree Master of Arts with the following exceptions. The unit requirement for this program is sixty units, of which twelve must be history of art and 48 in studio art courses. In lieu of a thesis, a terminal project or the equivalent of a terminal project, a selected work, or works, for departmental collections a selected work, or works, for the candidate's Master of Arts with the following exceptions. The unit requirement for this program is sixty units, of which twelve must be history of art and 48 in studio art courses. In lieu of a thesis, a terminal examination. The candidate may be required to prepare a one-person exhibit of the work or to participate in a group exhibit during the last semester in residence.

Major in Creative Writing

The unit requirement for this program is 48 units. Required are six graduate literature courses in the English Department, including two literature seminars for writing students. The program also requires the writing of an original book-length work of fiction or poetry. The rest of the program may be in writing courses, in literature, or in courses of other departments that relate to the student's field of interest such as playwriting, film-writing anthropology, history, or the literature of other languages. A final examination on modern literature is given at the end of the student's work. There is no foreign language requirement.
Applicants for the acting-directing option must submit a resume and at least three letters of recommendation and must arrange for an audition and inter-
view. Applicants for design-technical production must submit renderings and slides or phototypes of theatrical design or technical work directly to the department. Applicants for dra-
atric writing must submit at least two samples of original dra-
atric writing and letters of recommendation from at least three
ions acquainted with the student as a writer.

**Acting-Directing Option:** (a) Acting Emphasis. Program requirements are 504, 549, 551, 552, 575, 4 units of 597, 600, 65, 606, 650, 655, 656, 693, 4 units of 696b, 909, 6 additional
its of theatre history, dramatic theory, or criticism, 3 units of nc. 691, and one unit of Mus. 693. In lieu of a thesis, each 
udent must present a monograph on the direction of a play, presented and 
apped according to departmental guidelines. (b) Directing Emphasis. Program requirements are 531, 549, 551, 552, 556, 575, 4 units of 597, 600, 605, 66, 650, 655, 656, 693, 3 units of 696b, 3 units of 696d, 909, 6 addi-
ional units of theatre history, dramatic theory, or criticism, and one unit of Dnc. 691. In lieu of a thesis, each student must
resent a monograph on the direction of a play, presented and 
apped according to departmental guidelines.

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

**Dramatic Writing Option:** Program requirements are Dram. 60a-60b, 600, 640, 641, 642a-642b, 644, 9 units of 696, 909, and 2 units of drama production including acting, directing, scenic design, lighting design, costume design, costume production, and technical production. Degree requirements are at least forty units of graduate level design, technical production and/or theatre workshop courses. In lieu of a thesis, each student must present a monograph on the direction of a play, presented and approved according to departmental guidelines.

**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 reasons for desiring graduate study in landscape architecture. They should also have three letters of recommendation sent. Both the statement and the letters should be addressed to the Graduate Admissions Committee, Program in Landscape Architecture, School of Renewable Natural Resources, University of Arizona.

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

**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 581; 507 or 581. Students who have completed courses similar to these at other institutions may have these courses waived as requirements. Written petition for waivers must be made to the Graduate Library School in the student's first semester in the program.

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

Holders of Arizona teaching certificates may acquire the school librarianship endorsement appropriate to their certifi-
cates by completing one of the following programs: elementary school—Li.S. 485, 502, 503, 505, and 581; secondary school—Li.S. 485, 502, 503, 505, and 581.

**Master of Music**

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

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

Major in Composition

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

Major in Musicology

This major requires a minimum of 30 graduate units of which at least 12 must be in musicology. A thesis is required, as is a reading knowledge of French or German.

Major in Music Education

Applicants for master's degree programs in music education must qualify for teacher certification prior to completion of the degree. Students may select a concentration in instrumental, choral, or general music or may participate in the design of a program suited to individual professional objectives. All programs require a minimum of 30 graduate units. No more than six units of credit in special workshops may be substituted for courses in music education. The degree culminates in a major project which demonstrates individual accomplishment of a creative, pedagogical, musical, or scholarly nature.

Major in Music Theory

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

Master of Public Administration

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

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

M.A.P. 503 Human Resources Management
M.A.P. 502 Organization Theory and Behavior Relations
M.A.P. 601 Public Management
Pol. 595g Seminar in Public Policy
Econ. 500 Managerial Economics
Econ. 534 Public Finance
M.A.P. 610 Fiscal and Budgetary Administration in the Public Sector
M.I.S. 552 Statistical Decision Making
M.A.P. 605 Research and Evaluation in Public Management

The second segment is a 9-unit stream of concentration in either management or policy. The management stream offers skills training for students wishing to pursue managerial administrative careers. The policy stream offers a program for those interested in program analysis, government or policy specializations.

The third segment is a 12-unit specialization in a substantive area of study. Specializations include health care, long-term care, and criminal justice and additional specializations are being developed. Students with excellent first year records may design individual specializations if warranted.

Finally, a 6-unit internship is required.

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

Master of Teaching

The graduate programs leading to the Master of Teaching degree are intended for persons currently engaged in teaching or in other appropriate programs of training and development. The two majors available are elementary education and secondary education. At the time the catalog was being edited, revisions to many of the programs in the College of Education were being considered for approval. All current or prospective students should check with the Office of Student Services at the College of Education or the Division of Teaching and Teacher Education for information regarding the status or requirements of all programs and degrees.


**Requirements for Specialist Degrees**

**Educational Specialist**

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

**Admission**

At the time this catalog was being edited, revisions to many programs at the specialist level were being considered for approval. All current and prospective students should check with the Office of Student Services in the College of Education or the appropriate division for information regarding the status and requirements of all programs and degrees.

**Qualifying Examination**

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

**Time Limitations**

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

**Advisory Committee**

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

**Program of Study**

A program of study, recommended by the division head and approved by the Office of Student Services 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. Please see the Office of Student Services in the College of Education or the appropriate division for information on program requirements.

**Final Examination**

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

**Professional Experience**

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

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

Admission

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

Program of Study

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 advisor after consideration of previous academic work and experience, personal interests, and professional objectives. Two options are available: (1) 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. This option generally requires two semesters beyond the time required for completion of the master's degree (see the headnotes under Nursing elsewhere in this catalog). The thesis will be directed toward some aspect of nursing care in the selected subspecialty area. (2) An applicant who has completed the master's degree in nursing at an institution accredited by the National League for Nursing may receive the Nursing Specialist degree by completing a minimum of 28 units.

Qualifying Examination

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

Prior graduate credit completed in a master's program elsewhere and essentially equivalent to the master's program offered at the University of Arizona may be accepted in transfer if it is relevant to the specialist degree program at this institution and if the student has kept abreast of current developments in the field. Graduate credit to be applicable with full value toward the specialist degree shall have been earned not more than six years prior to the completion of the requirements for degree. Graduate courses taken more than six and more than ten years prior to completion of degree requirements will be counted for half credit toward the degree. Work more than ten years old is not accepted toward meeting degree requirements.

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

Specialist in Microbiology

The 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 in environmental health departments of various governmental agencies.

Admission

Admission requirements include: (1) a bachelor's degree in microbiology or a related field; (2) sixteen units of college level microbiology, including courses equivalent to University of Arizona courses in microbiology, geology, microbiology, introductory immunology, and pathogenic microorganisms; (3) chemistry (general chemistry and qualitative analysis—one year, organic chemistry—one year lecture 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 of trigonometry is prerequisite); (6) biology (one year of general biology or equivalent courses in botany and zoology); (7) satisfactory grades in all prerequisite courses. Students must register for the courses without receiving graduate credit. A research paper and a final comprehensive examination must be submitted at the discretion of the department.

Program of Study

To receive the Specialist in Microbiology degree, a student must receive grades of B or better in an appropriate course at the University of Arizona, execute successfully a comprehensive examination in an area of the specialist degree, and (3) demonstrate 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 required. A research paper and a final comprehensive oral examination, however, are required.

Students interested in pursuing a program leading to a Doctor of Philosophy degree with a major in microbiology or immunology should follow the curriculum outline under Master of Science degree program in microbiology and immunology described elsewhere in this catalog.
QUIREMENTS FOR DOCTOR'S DEGREES

TOR OF PHILOSOPHY

Arments which possess special advantages for original
igation accept prospective candidates for the degree of
of Philosophy. This degree requires distinguished attai-
t in a recognized field of learning demonstrated in a disser-
which contributes to the general fund of knowledge. It is
granted merely as a certificate of faithful performance of a
ribed program of studies and research.

ENCE AND CREDIT REQUIREMENTS

quivalent of at least six semesters of essentially full-time
uate study is required. Graduate credit earned at other
ed institutions, if accepted by the major department and
Graduate Council, may be counted toward the require-
ts for this degree.

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

student who proceeds directly, without a break in enroll-
t, from a master's degree to a doctoral degree in the same
r, may be permitted to apply one or more semesters of full-
enrollment in the master's program toward the residence
rement for the doctoral degree. If there is a change of
r or a break in enrollment, the residence requirement must
filled again for the doctoral degree. Graduate assistants
uate associates and students on appointment to any
ing or research position at the University can discharge
imum residence requirement by four semesters during
of which they register for six or more units of work for
uate credit, provided their full time is devoted to the their
graduate work and meeting the responsibilities of their
ments.

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 academic unit, dissertation
work may be done in absentia.

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

MAJOR AND MINOR SUBJECTS

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

QUALIFYING EXAMINATION

For the purpose of demonstrating acceptability to undertake
work leading to candidacy for the doctorate, each prospective
candidate must pass a qualifying examination in the proposed
major field. The examination is waived at the discretion of the
department in a field in which the candidate has done major
work toward a completed master's degree at the University of
Arizona. The examination should be taken during the first
semester of residence and preferably during the first two
weeks of residence. Many departments also require a qualify-
ing 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 depart-
ment 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 non-dissertation units proposed. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level or above, university-credit courses, and that at least one half of the required units be offered in university graduate credit courses in which regular grades (A, B, C) have been earned. (For specific degree requirements, consult the section on academic departments.)

**Foreign Language Requirement**

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

**Preliminary Examination**

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

**Advancement to Candidacy**

After satisfying any language requirements, passing the preliminary examination, and showing evidence of ability to do original research, the student will 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. The Request Form shall be accompanied by a copy of the penultimate draft of the dissertation to be delivered to the Graduate College representative appointed to the examining committee. Following the examination, the Graduate College representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Check Office. The candidate submits 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), along with the approval pages and special abstract. After making any required corrections, the candidate submits two complete and signed copies of the dissertation to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier. The College of Education requires two additional copies of the dissertation, one to the College of Education files and one for the dissertation director. In other colleges, the major department, at its option may require an additional copy for the departmental files. 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, at Arbor, Michigan, and a fee of $25 is charged to cover the 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 30 words or less are forwarded to University Microfilms. (The abstract is in addition to the two abstracts required for inclusion in the dissertation and must be carefully prepared for microfiling according to specifications set forth in the Dissertation Manual.) The manuscript is cataloged and microfilmed and 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 selected list of journals and abstracting services. The copy then returned to the University of Arizona library.

Publication by microfilm does not preclude publication of other means 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 from related to the field of study. The exact time and place of this examination shall be scheduled with the Graduate College in consultation with the major and minor departments. No later than three weeks prior to the proposed date of the examination, the request for the oral examination shall be scheduled with the Graduate College and notification of the date and time shall be announced public 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**

Prior to the final examination and in addition to the preliminary examination and the regularly scheduled course examination the candidate may be required to take any other examination 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 Doctor of Education. The degree is granted only to those who demonstrate a high proficiency in education and who present an approved dissertation. (For the degree of Doctor of Philosophy, see above.) At the time this catalog was being edited, revisions to many Doctor of Education programs were being considered for approval, with implementation anticipated for the 1989 fall semester. All current and prospective students should check with the Office of Student Services in the College of Education or the appropriate division for information regarding the specific requirements of all programs and degrees.
Residence and Credit Requirements

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 academic units. No later than three weeks prior to the proposed date of the examination, the Request to Schedule Preliminary Oral Examination must be filed with the Graduate College. The preliminary examination will be held when essentially all course work has been completed and in any case not later than three months prior to the date of the final oral examination. No student will be permitted a second attempt to pass the preliminary examination except upon recommendation of the examining committee, endorsed by the major department and approved by the Graduate Council. The second examination, if approved, may not take place until four months from the date of the first examination. The only visitors permitted at the preliminary examination are regular University faculty members.

Advancement to Candidacy

After passing the preliminary examination and giving evidence of ability to carry on professional studies at the highest level, the student will be recommended to the Graduate Council for acceptance as a candidate for the doctorate. 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. The Request Form shall be accompanied by a copy of the penultimate draft of the dissertation to be delivered to the Graduate College representative appointed to the examining committee. Following the examination, the graduate College representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Check Office. The candidate submits the completed dissertation to the University Library. A processing fee must be paid to the University Cashier. The College of Education requires two additional copies of the dissertation, one for the College of Education files and another for the dissertation director. A manual of instructions relating to the form of the dissertation may be obtained from the Associated Students' Bookstore.
Publication of Dissertation

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

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

Final Examination

When the required standards of scholarship have been met and research ability has been demonstrated, the candidate shall submit to an oral examination in defense of the dissertation, as well as any general questioning related to his or her field of study which may develop therefrom. The exact time and place of this examination shall be 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 divisions and/or departments.

Doctor of Musical Arts

The School of Music, through the Graduate College, accepts prospective candidates for the degree of Doctor of Musical Arts. The degree is granted in the fields of composition, conducting, and performance. It is not granted merely as a certificate of faithful performance of a prescribed program of studies but requires demonstration of distinguished attainment. Information about the Doctor of Philosophy degree with a major in music theory or music education will be found under “Music” in the forthcoming issue of Microfilm Abstracts. Suitable acknowledgement must always indicate the publication to be a dissertation or portion of a dissertation, submitted in partial fulfillment of the requirements for the degree of Doctor of Education at the University of Arizona.

Major and Minor Subjects

The student will major in conducting, composition, or performance, and choose a minor subject in another area of music or in a department other than music if approved in the candidate's college record and musical achievement, and evidence of an ability to write in a clear and precise manner are required.

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, the examinations should be taken during the first semester in residence. In addition, a personal interview, a review of the applicant's college record and musical achievement, and evidence of an ability to write in a clear and precise manner are required.

Advisory Committee

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

Program of Study

A proposed program of study recommended by the School of Music and any other department concerned 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 core recital/dissertation units proposed. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level courses.
bove, university-credit courses, and that at least one half of
required units be offered in university graduate credit
courses in which regular grades (A, B, C) have been earned.

specific degree requirements, consult the paragraphs on
specific requirements for the majors in composition, con-
ting and performance at the end of this section.)

Ilminary Examination

ore admission to candidacy for the degree, the student
must pass a general examination in the chosen fields of study.

examination is intended to test the student's general fun-
damental knowledge of the fields of the major and minor sub-
jects of study. It shall include written portions covering the
or and minor fields and, no later than six months after suc-
sessful completion of the first of these portions, an oral portion
shall be conducted before a committee of the faculty
jointed by the Dean of the Graduate College upon consulta-
tion with the major and minor departments. No later than three
weeks prior to the proposed date of the examination, the
quest to Schedule Preliminary Oral examination must be filed
with the Graduate College. The preliminary examination will be
d when essentially all course work has been completed and
may not later than three months prior to the date of the
oral examination. No student will be permitted a second
attempt to pass the preliminary examination except upon rec-
ommendation of the examining committee, endorsed by the
major faculty and approved by the Graduate Council. The sec-
tional examination, if approved, may not take place until four
weeks from the date of the first examination. The only visitors
mitted at the preliminary examination are regular University
ulty members.

vancement to Candidacy

or passing the written and oral portions of the preliminary
amination and giving evidence of ability to carry on profes-
sional studies at the highest level, the student will be recom-
nended to the Graduate Council for acceptance as a
andidate for the degree of Doctor of Musical Arts. These
quirements must be met no later than three months prior to
final oral examination.

al Examination

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

pecific Requirements for the Major in Composition

ovalement of a major in composition will be based upon evi-
dence of creative talent and a knowledge of craftsmanship in
ning music.

In lieu of a dissertation, the candidate will compose a major
work of approximately thirty minutes duration. Registration for
eighteen units of dissertation credit (920) is required during the
preparation of the composition with a maximum of nine units
during any regular semester. A penultimate draft of the com-
position must accompany the Request to Schedule the Final
Oral Examination. Following the examination the candidate
submits to the Graduate College a final copy (approved and
accepted by the School of Music and all members of the exam-
ing committee) together with approval pages and special
abstract. The abstract addresses the formal, stylistic, and tech-
nical elements of the composition. Upon acceptance by the
Graduate College, the candidate submits two complete signed
copies of the composition to the Graduate College for delivery
to the University Library. The School of Music, at its option, may
require an additional copy for its files. Regulations governing
publication of the composition are the same as those governing
publication of a Ph.D. dissertation.

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

Specific Requirements for the Major in Conducting

Requirements are the same as for Performance majors (see
below), except that conductors generally fulfill each recital
requirement (except the lecture recital) through several perfor-
ances with major university ensembles. Conductors work in a
secondary conducting area for the second recital.

Specific Requirements for the Major in Performance

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

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

The candidate will prepare and submit a formal document in
connection with the lecture-recital. This document, based on
some aspect of performance or performance practice, must
show evidence of the candidate's ability to select and organize
data pertinent to the study. The document should be an original
contribution to the field of knowledge in the candidate's chosen
subject area, and should demonstrate the candidate's ability to
communicate effectively in writing. Following a successful final
oral examination, the candidate will submit one bound copy of
the Lecture Recital Document to the University Music Library
for placement in its permanent collection.
Course Listing Information

Curricular Change—Course listings in the following departmental sections are subject to change. Curriculum changes approved during the first year of the catalog's 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 University Curriculum Office, Administration Building, Room 412c.

Class Schedules—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 at the Information Desk of Registrar Data Processing, Administration Building, Room 210, in April and October, respectively. The Summer Session Schedule of Classes is available in February at the Administration Building, Room 210. For a complete statement of the student's responsibility in maintaining acquaintance with current university requirements, see the copyright page of this catalog.

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.

Cancellation of Courses—The University reserves the right to cancel courses not elected by an adequate number of students.

Course Numbering System

Classification of Courses—The number by which a course is designated indicates the level of the course. Graduate credit courses are listed by level as follows (for undergraduate course listings, see the General Catalog):

| 500-599: | Graduate courses. Open to exceptionally well-qualified seniors with the prior written approval of the course instructor and the Graduate College. |
| 600-699: | Graduate courses. Not open to undergraduate students. |
| 700-799: | Graduate courses limited to doctoral students. |
| 800-899 | Courses limited to students working toward degrees offered by the College of Medicine or the College of Pharmacy. Not available for credit toward other degrees. |

Semester Courses (Single Numbers)—A course designated by a single number (as Econ. 560) is one semester in length.

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

Course Description Explanation

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

Sample Course Listing:

| 506. Social Structure in Modern Societies (3) [Rpt.] 1989-90 | Critical review of modern theory and research on social structure and social organization in modern societies. 2R, 3L. P & units of sociology or CR. (Identical with Hist. 506) Smith |
| 506—Course number. |
choical Structure in Modern Societies—Course title.
—Number of units.

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

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

89-90—Year in which course is offered. If no year designation is given, the course is offered each year.

Critical review...societies.—Course description.
I, 3L—Class structure. R, L, and S indicate “recitation,” “laboratory,” and “studio.” 2R, 3L indicates that the class meets 2 hours of recitation and three hours of laboratory per week (15 weeks). For courses consisting of lecture and recitation periods only, the number of class hours per week is the same as the unit value and is not specified in the course description.

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

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

Level with Hist. 506—Crosslisting. Identifies other departments which give credit for the same course. The course description is shown in the course list of the department with structural responsibility for the course. If no course description appears, consult the crosslisted department.

II—Professor in charge.
\*—Not all of the above information may be noted in any individual course.

University-Wide “House-Numbered” Courses

Basic University of Arizona courses use a combination of lecture, discussions and laboratories as their basic teaching format. University-wide “house-numbered” courses identify generic teaching formats which emphasize student participation, typically in small group or individual settings. Small-group courses are identified by numbers ending in 95, 96 or 97. The area of study for such courses is indicated through a prefix and subtitle. Individual-studies courses are those numbered that numbers ending in 91, 93, 94, and 99, as well as all 900-level courses. Under their generic numbers and titles, and with their subscripts, they are available for use by all departments at course-number levels appropriate to the departments’ academic programs.

Small-Group Courses

15, 695, 795. Colloquium (Credit varies) The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.

15, 696, 796. Seminar (Credit varies) The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
Grades Available: A, B, C, D, E, I, S/P, W.

597, 697, 797. Workshop (Credit varies) The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.
Grades Available: A, B, C, D, E, I, W.

*Special courses S P C D E I or regular grades may be used as departmental policy dictates; however, in any 909 course offering, all registrants must be graded by the same system.

Individual Studies

591, 691, 791. Preceptorship (Credit varies) Specialized work on an individual basis, consisting of instruction and practice in actual service in a department, program, or discipline. Teaching formats may include seminars, in-depth studies, laboratory work and patient study.
Grades Available: S/P, C, D, E, I, W.

593, 693, 793. Internship (Credit varies) Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grades Available: S/P, C, D, E, I, W.

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

594, 694, 794. Practicum (Credit varies) The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.
Grades Available: S/P, C, D, E, I, W.

599, 699, 799I. Independent Study (Credit varies) Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grades Available: S/P, C, D, E, I, W.

900. Research (Credit varies) Individual research, not related to thesis or dissertation preparation, by graduate students.
Grades Available: S/P, C, D, E, I, W.

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

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

910. Thesis (Credit varies) Research for the master’s thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grades Available: S/P, E, K, W.
915. Master’s Recitals (Credit varies) For master’s students in performance.
Grades Available: S/P, E, K, W.

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

925. Doctoral Recitals (1 to 9) For doctoral students in music performance.
Grades Available: S/P, E, K, W.

930.** Supplementary Registration (1 to 9) For students who have completed all course requirements for their advanced degree programs. May be used concurrently with other en-
tments 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
register for credit under course number 599, 699, or 799.

**Graduate students who have completed the course requirements of their programs and
be taking examinations or completing projects initiated at the time they register for supplementary registration. Students completing requirements for advance-
degrees must be registered during the semester of summer term in which requirements
comprise the candidate for the previous semester or term if required during
intercession. Students who have previously enrolled for all the required courses required for
degrees may register for supplementary registration (course number 930, one unit only).
Graduate students using university facilities or faculty time must register for a minimum of
units of 930 during fall and spring semesters, and for one unit of 930 during summer sessions
if used for anything other than research. Credit received for this course is in addition to the or
required for the advanced degree.

Academic Departments and Committees

Permanent graduate credit courses offered by the University of Arizona are listed on the following pages by academic unit in alphabetical order.

Accounting (ACCT)

BPA Building, Room 308
(602) 621-2620

Professors Russell M. Barefield, Head, William B. Barrett, Dan S. Dhalwill, William L. Felix, Jr.
Associate Professor William S. Waller
Assistant Professors Joseph G. Fischer, Sharon S. Lasser, Marcia S. Niles, Graeme W. Rankine, Jeffrey W. Schatzberg, E. Kay Stice

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 of Degrees/Master of Business Administration, Master of Public Administration and see also Business Administration and Management and Policy headnotes elsewhere in this catalog.

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.

511. Readings in Information Systems (3) I (Identical with M.I.S. 511)

522. Advanced Federal Taxation (3) I Introduction to advanced topics: taxation of corpo-
rations and stockholders’ transactions in stocks; taxation of partnerships and fiducianies; gift and estate taxation.

*May be converted with 400-level course.

523. Estate Planning and Taxation (3) I Advanced topics on gift and estate tax: emphasis on the planning and structuring of financial activities to minimize the impact of income and wealth-transfer taxes. P. 422, M.A.P. 426 or CR.

526. Corporate Taxation (3) I 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) I 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 busi-

ness, installment sales, and depreciation recapture provisions. P. 401, 422.

528. Taxation of Partnerships (3) I Concepts and principles of partnership income taxation and the uses of partnerships for tax planning. P. 401, 422.

531. Responsibilities of the Public Accountant (3) I Professional courses for those who expect to pursue public accounting as a career. P. 431.

550. Financial Accounting Analysis (3) I 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) I 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 non-
majors only. Open only to students admitted to BPA graduate programs. P. 550, Econ. 500a or CR, M.A.P. 552 or CR.

553a-553b. Financial Accounting (3-3) I II Theory and methodology of net income deter-
mination; accounting for assets, liabilities, and owners’ equity. Credit allowed for this course or 300a-300b, but not for both. P. 210 or 551.

555. Tax Factors in Business Decisions (3) I 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 pro-
grams. Not open to accounting majors. Credit allowed for this course or 320, but not for both. P. 210 or 551.

556. Design and Control of Production Systems (3) I (Identical with M.I.S. 556)

556. Information and Financial Decision Support for Investment Planning (3) I I Accounting and finance theory for investment planning and implementation. An MBA integrative course. Open only to students admitted to BPA graduate programs. P. 550, Fin. 511. (Identical with Fin. 569)

561. Management and Evaluation of Information Systems (3) I I (Identical with M.S. 570)


585. Contemporary Financial Accounting Thought (3) I Special topics in accounting the-
ory and research. Of special interest to doctoral students. P. 682.

966. Seminar (1-3) I II

a. Auditing (1-3) I II
b. Managerial Accounting (1-3) I II
c. Taxation (1-3) I II
d. Theory (1-3) I II
e. Behavioral (1-3) I II

967. Aerospace and Mechanical Engineering (AME)

AME Building, Room 301
(602) 621-2236

Professors Chuan F. Chen, Head, Roger I. Anderson (Emeritus), Francis H. Champagnie, Harvey D. Christensen (Emeritus), Hermar F. Fasel, Hussein A. Kamel, Dimitri B. Kerciglou, Robert B. Kinney (Emeritus), Don M. McEligot (Emeritus), Edwin K. Pai (Emeritus), Henry K. Schummers, Jr., Russell J. Petersen, Robert B. Roerner, Lawrence S. Scott, Jr., William R. Sears (Emeritus), Que-
tin R. Thomson (Emeritus), Thomas L. W. cent, Paul H. Wathen, I.J. Wygnanski, Ralph Yappel (Emeritus)

Associate Professors Thomas F. Balsa, Ke Ying Fung, Edward B. Hauguen (Emeritus) C. Heinrich, Karl Seeger, S.F. H. Lichter, Parvez E. Nikravesh, Kumar N. Ramohalli, Bruce R. Simon

Assistant Professors Ara Arabyan, Cho U. Chan, Abhijit Chandra, Ari Giezer, Shi I. Joshi, Alfonso Ortega, Arne J. Pearlstein, Robert A. Peterson

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in aerospace engineering and 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 curricular of a recognized institution of higher education is required of applicants to the graduate pro-
gram. In general, a grade average of "B" or better in previous academic work is expected. Graduates from other engineering, mathem-
tics, and physical sciences curriculum may admitted provisionally. All applicants must submit scores from the Graduate Record Exam-
nation general test and Engineering subject tests.

Majors

Aerospace Engineering: Master of Science or Doctor of Philosophy degree programs prepare students for advanced work in aeronautics. Several specializations are avail-
able, as listed under Mechanical Engineering below.

Mechanical Engineering: Master of Science and Doctor of Philosophy degree pro-
gram prepare students for advanced work in materials engineering. Students in this 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 curricular of a recognized institution of higher education is required of applicants to the graduate pro-
gram. In general, a grade average of "B" or better in previous academic work is expected. Graduates from other engineering, mathem-
tics, and physical sciences curriculum may admitted provisionally. All applicants must submit scores from the Graduate Record Exam-
nation general test and Engineering subject tests.

Majors
trol and optimization; reliability engineering; I probabilitic design; solar energy; solid
chanics and structural dynamics; space items engineering.

III. Stress of Science: All students are required to complete 31 units of graduate work, including at the 500 level and 1 unit of 696. A student may elect to present a Master's thesis (up to six units) or a Master's report (up to three units). All dents are required to complete 532a-532b, unless permission by engineering option y take 513a-513b as a substitute.) Normally, more than three units of independent study sponsored-projects courses may be taken degree credit. All students are expected to and the weekly graduate seminar. A final oral ination is required.

Doctor of Philosophy: Students should take: Qualifying Examination during their first semester in residence. After completing all or any the required course work, the Pre-
imary Examination may be scheduled. Writ-
e examination on the major subject is given by the instructor and written examina-
tion on the minor subject. Minor subjects y be chosen from other engineering, physi-
sciences, or mathematics departments. All items are expected to attend the weekly rospace and Mechanical Engineering minars.

3. Modeling and System Identification in namic Engineering Systems (3) I 1989-90 niples of mathematical modeling of engi-
nering problems; state and parameter identifi-
tion techniques; lumped and distributed stem; open loop (explicit) and closed loop (implicit) applications; frequency and time main representation; deterministic and chastic inputs. P, 310, CR, 405.

4. Optimal Control of Dynamic Systems II 1989-90 Mathematical description of control problems; optimal control theory; track and guidance; space systems, feedback control design, vector-valued st, qualitative methods; numerical tech-

5. Mechanics (3-3) II 1990-91 Continuum mechanics; structural dynamics; mechanical behavior of composite materials; mechanical behavior of laminates; mechanical behavior of short fiber composites. P, 310, C.E. 217.

539. Advanced Structural Mechanics (3) III Advanced problems in structural analysis using the finite element method; analysis and optimiza-
tion of complex systems; nonlinear and com-
postie structures and material systems; application to other disciplines. P, 436. (Ident-
ical with E.M. 539).

540. Advanced Thermodynamics (3) I Rhe-
sible and irreversible macroscopic thermo-
dynamics; selected engineering applications. P, 240, 331a.

541. 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.

542. Convective Transport Phenomena (3) I Convection, energy, mass and momentum trans-
fer, internal and external flow; exact, approximate and numerical solutions; application to current problems. P, 442, CR, 532a, computer programs and applications.


545. Combustion Generated Air Pollution (3) II Pollutant formation in combustion processes and combustion models for atmospheric dispersion, including plume rise calculations. P, 420, 33ta. (Identical with Ch. 545).

546. Nature of Turbulent Shear Flow (3) I 1990-91 Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances. P, 520a-520b, 523b.

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

553. Aerodynamics of Propulsion (3) I 1989-90 Interior ballistics of rocket motors; ram-
jets, turbosjets, turboprops; detonation wave the-
ory; combustion chamber instability analysis; nozzle design. P, 461.

556. Combustion Gasdynamics (3) II 1989-90 Aerothermodynamics; fluid mechanics, ther-
modynamics, chemistry of propulsion and air pollution; reaction kinetics, combustion stability, detonation; turbulent perturbations in delfgra-

559.* HVAC System Design (3) II (Identical with N.E.E. 559)

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.

561. Compressible Aerodynamics (3) III Invis-
cid and compressible fluids; governing equations and their method of solution for sub-
sonic, transonic, supersonic, and hypersonic flows. P, 461, 532a.

568. Medical Engineering (3) III One sub-
ject covered yearly from: biomechanical-sold mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); biomechanics of short fiber composites. (Temperature regulation exercise, hyperthermia, instrumenta-


538.* Composites Materials (3) II Classification and characteristics of composite materials; mechanical behavior of composite materials, micro- and macro-mechanical behavior of lami-

537.* Engineering Program Design and Im-
plementation (2-4) II Hardware and software.


538.* Composites Materials (3) II Classification and characteristics of composite materials; mechanical behavior of composite materials, micro- and macro-mechanical behavior of lami-

537.* Engineering Program Design and Im-
plementation (2-4) II Hardware and software.

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.

616. Convective Stability (3) II 1969-90 Linear and nonlinear stability theory for thermally or chemically stratified flows; doubly-diffusive effects; analytical and numerical methods; materials processing and geophysical applications. P: 520a-520b, 532a-532b.

621. Advanced Computational Aerodynamics (3) I Governing equations for aerodynamic applications; iterative techniques for solving linear and nonlinear systems; numerical 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
a. Graduate Seminar (1) I II

Agricultural Biochemistry and Nutrition (See Nutritional Sciences)

Agricultural Economics (AEC)
Economics Building, Room 208
(602) 621-6241

Professors Jimmye S. Hillman, Head, Robert C. Angus, Bartley P. Cardon, Dennis C. Cory, Robert S. Firch, Roger W. Fox, Maurice M. Kelso (Emeritus), Robert O. Kuehl, William E. Martin

Associate Professors David L. Barkley, Merle D. Faminow, Eric A. Monke, Paul N. Wilson

Assistant Professors David K. Blough, Roger A. Dahlgren, Gary D. Thompson

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 a technical paper option must complete 33 semester units including three units of 900 in which the technical paper is prepared.

500. Research Methodology in Agricultural Economics (3) I 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 product; risk and uncertainty. (Identical with Econ. 504) Wilson

512. International Agricultural Economic Development (3) I The role of agriculture, 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 Policy and Marketing Analysis (3) I Market organization, efficiency, and functions in a dynamic economy. (Identical with Econ. 513) Faminow

514. Conduct Analysis (3) II Theoretical bases and empirical techniques, with emphasis on LDCs. Consumer-producer surplus; social and private costs; macroeconomic distortions; non-market goods; uses in policy analysis. (Identical with Econ. 514 and M.A.P. 514) Monke


516. * Rural Area Development (3) I Identification of current U.S. nonmetropolitan problems, economic theories useful in analyzing these problems, and possible program alternatives for rural area development. (Identical with Geog. 516)

539. Statistical Methods (4) I I Concepts and methods of statistical inference including classical and nonparametric procedures for estimation and hypothesis testing in common statistical parametric research. We shall discuss sample techniques, linear regression, analysis of variance, and contingency tables. P: College Algebra. (Identical with Gene. 539). Blough/ Kuehl

540. Design and Analysis of Experiments (3) II Statistical principles of research design for experimental and observational studies; introduction to the linear statistical model for analysis of data from research studies including techniques for complete block and incomplete block designs; factorial experiments; covariates and polynomial response functions. P: 539. Kuehl

542. * Transformation of Agrarian Societies in the Middle East (3) II (Identical with Or.S. 542).

544. In the Wake of the Green Revolution (1) I [Rpt.] I I (Identical with Anth. 544)

547. * Consumer Economics (3) I I (Identical with C.S. 546) [Rpt.]

547. * History of American Agriculture (3) II (Identical with Hist. 547)

549. Agricultural Economic Analysis (3) II (Identical with Econ. 549) Dahlgren

550. * Agricultural Finance (3) I Applying business and economic theory to problems confronting agribusiness firms in the acquisition, allocation, control, and transfer of capital resources. P: 215, or Econ. 300 and 3 units of accounting. Wilson

559. * Agricultural Economic Development in Latin America (3) I Review and analysis of economic growth and development in Latin America with emphasis on the agricultural sector. (Identical with Econ. 559 and Anth. 559) Fox/Finan

567. * Population and Development in the Middle East (3) I I (Identical with Or.S. 567)

571. * Problems in Regional Development (3) I I (Identical with Geog. 571)


580. * Forest Policy and Administration (3) (Identical with Ws.M. 580)

*May be convened with 400-level course.

Agricultural Education (AED)
Agriculture Building, Room 222A
(602) 621-1523

Professors Floyd G. McCormick, Head, God J. Graham, Clinton O. Jacobs (Emeritus) Kenneth S. Olson, Phillip R. Zurbrick

Associate Professor Christopher J. Kalangi

Assistant Professors David E. Cox, Glen 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 completion of at least twenty units in agricultural education. Supporting work shall be in business administration, educational psychology, sociology or in another approved field appropriate to the student's educational interest. A thesis, or a comprehensive examination, is required. 30 units, including 12 units of agricultural education. Thirty units, including 12 units of agricultural education or a thesis (for which a maximum of six units may be earned) must be completed.

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

538. Philosophy and Principles of Extension Education (3) I Social and economic significance of extension education in domestic and international situations. P: 12 units of agricultural or family and consumer resources. (Identical with H.E.E. 538)

539. Extension Education Methods (3) I Application of competencies in the development and application of non-formal educational methods used by change agents to diffuse practical information. P: 6 units of agricultural education or education. (Identical with H.E.E. 539)

540. International Agricultural Extension Education (3) I Identification and discussion of number of critical factors peculiar to agricultural extension and rural development of the developing countries. Working and living overseas are required. (Identical with H.E.E. 540)

542. Education for Agricultural Entrepreneurship (3) I Pedagogy of developing motivation, skills and knowledge needed to start new enterprises in agriculture. Field trips. P: 6 units of macro/microeconomics with emphasis on management.

587. Workshop
a. Extension Experience Program (1)
[Rpt. /2] I I
b. Youth Leadership Development (1)
[Rpt. /3] I I
c. *Extension Credibility and Accountability (1-2) [Rpt.] I I (Identical with H.E.E. 587)

*Administration, Management, and Supervision of Cooperative Extension (1-2) [Rpt.] I I (Identical with H.E.E. 587d)
Continuing Education in Agriculture (1-3) [Rpt./3] II Program Planning and Evaluation (1-3) [Rpt./3] II Micro-computers-Extension (1-2) [Rpt./2] (Identical with H.E.E 597g)

Video Communications and Methods (1-2) [Rpt./2] (Identical with H.E.E 597h) Principles in Engineering Design (1-2) (Identical with H.E.E 597t) Public Policy Issues (1-2) (Identical with H.E.E 597n)


Administration of Extension Programs (1-3) II (Identical with H.E.E 597w)

Continuing Education in Agriculture (1-3) II Program Planning and Evaluation (1-3) II Micro-computers-Extension (1-2) II Video Communications and Methods (1-2) II Principles in Engineering Design (1-2) II Public Policy Issues (1-2) II

Program Planning (3) II Developing pro- grams in agricultural teaching and extension; analysis, objectives, policies, content, xed procedures for conducting investigations; selecting programs for planning; 

Adult Vocational Education (3) II Organization, content, and techniques for conducting adult education programs; characteristics of adult learners; issues affecting adult education. P, bachelor's degree and 4 year teaching experience.

Agricultural Engineering (AEN)

Gintz Building, Room 507 02) 621-1607

Josephson Gene M. Nordby, Head, Delmar D. Fangmeier, Richard K. Frevert (Emeritus), Kenneth R. Frost (Emeritus), William E. Hart, Jordan, W. Gerald Matlock (Emeritus), Donald C. Slack, Frank Wiersma Associate Professors: M.D. Cannon (Emeritus), Wayne E. Coates, Dennis L. Larson Assistant Professor: Gregory J. Fleischman, Muluneh Yitayew

Electrical Engineering offers graduate work leading a Master of Science degree in the major in electrical engineering and a Doctor of Philosophy degree with a major in irrigation engineering.

Opportunities for study and research in sev- eral areas of concentration exist including the following:

- Irrigation and water resources management
- Biosystems engineering
- Alternative energy sources
- Water and environmental management
- Agricultural engineering with emphasis on biotechnology developments
- Energy issues and alternatives
- Development of food processing and agricultural equipment and machinery
- Biosystems analysis and design
- Waste management and water quality control
- Soil, water, plant relationships
- Drainage and irrigation systems
- Artificial intelligence and multiple-spectral analysis
- Robotics
- Emerging technologies in these areas

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

A thesis is normally required, but the require- ment may be waived for a student whose senior author of a manuscript published in a refereed professional journal.

Technology courses offered for non- engineering students desiring background in irrigation, water management and food engineering are listed separately below.


557. Irrigation Engineering Laboratory (2) I Methods of data collection and analysis which are pertinent to the design of irrigation systems. Computer-aided acquisition and processing will be used in many laboratory exercises. 1R, 3L. Field trip P, 455.


605. Soil-Water Dynamics (3) II 1990-91 (Identical with S.W. 605).

650. Irrigation Management (3) II 1989-90 Irrigation scheduling using Jensen-Haise and Penman equations for predicting evapotranspiration; determination of crop coefficients; production functions, economics, and energy considerations. P, 404 or 455 or S.W. 605.

655. Surface Irrigation Analysis (3) I 1989-90 Analysis of design and operating criteria for basin, border and furrow irrigation systems, effect of field parameters on system design. Evaluation criteria for existing systems. P, 456.

656. Pressurized Irrigation Systems (3) II 1989-90 Analysis of design and operating criteria for sprinkler and trickle or drip irrigation systems, application of irrigation principles to design and system evaluation. P, 456.

696. Seminar (1-2)

a. Soils, Water and Agricultural Engineering (1) [Rpt./1] I (Identical with S.W. 696a) Wiersma

* May be convened with 400-level course.

Agriculture (AGRI)

Within the College of Agriculture, programs are offered leading to the Bachelor of Science (B.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 .................................................. M.S.
Agricultural Education .................................................. M.S./M.Ag.Ed.
Agricultural Engineering ................................................ M.S.
agriculture engineering ................................................. M.S.
Animal Sciences ............................................................ M.S.
animal science ............................................................... M.S.
dairy science ............................................................... M.S.
poultry science ........................................................... M.S.
Entomology ................................................................. M.S./Ph.D.
Nurturing and Food Science ......................................... M.S.
dietetics ................................................................. M.S.
food science ............................................................... M.S.
Nutritional Sciences .........................................................
Plant Pathology .......................................................... M.S./Ph.D.
Plant Protection ........................................................... M.S.
Plant Sciences ............................................................
agronomy and plant genetics ........................................ M.S./Ph.D.
hydrology ................................................................. M.S.
Renewable Natural Resources ..............................................
landscape architecture .................................................. M.L.Arch.
range management ........................................................ M.S./Ph.D.
water resources studies ................................................ M.S./Ph.D.
watershed management .................................................. M.S.
wildlife and fisheries science ........................................... M.S./Ph.D.
Soil and Water Science ................................................ M.S.
soil and water science ................................................... M.S.
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 completion 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.

Agronomy and Plant Genetics
(See Plant Sciences)

American Indian Studies (AINS)

Social Sciences Building, Room 324
(602) 621-7108

Committee on American Indian Studies (Graduate)

Professors Barbara Babcock (English), James W. Clarke (Political Science), Vine Deloria, Jr. (Political Science), Lawrence J. Evers (English), Jerrold Levy (Anthropology), N. Scott Momaday (English), James Oliver (Anthropology), J. Jefferson Reid (Anthropology), Susan W. Steele (Linguistics), Robert K. Thomas, Robert Williams, Jr. (Law)

Associate Professors Courtney Cieland (Sociology), Joy Harjo (English), Thomas M. Holm (Political Science), Alice S. Paul (Elementary Education), Assistant Professor Ofelia Zepeda (Linguistics), Director

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

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

Master's degrees (major in American Indian Studies): 30 units, plus a six-unit thesis. The course work consists of 15 units of core courses, including 502a-502b, 564a-564b, 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, literature, government, education, or any other related area approved by the Committee. 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.

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

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

504. *Sociology of the Southwest (3) I (Identical with Soc. 516)

516. *Contemporary Indian American (3) II (Identical with Anth. 516)

523. *Peoples of Mexico (3) II (Identical with Anth. 523)

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

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

557. *Race and Ethnic Relations (3) I II (Identical with Soc. 557)

577. Ethnomic Literature (3) A North American Indian Literature (3) (Identical with English 577a)

582. *Hopi Language in Culture (3) II (Identical with Anth. 582)

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

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

May be conferred with 400-level course.

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

595. Colloquium

596. Seminar

a. American Indian Law and Policy [Rpt. 2] (1) (Identical with Pol. 59 which is home.)
b. American Indian Law and Policy (3) (Identical with Pol. 59 which is home.)
c. Studies in the Oral Tradition (3) [Rpt. 3] units I (Identical with Anth. 59 which is home.)

631. Indian Law (3) I (Identical with Law 6)

Anatomy (ANAT)

Arizona Health Sciences Center, Room 4205
(602) 626-6084

Professors Robert S. McCuskey, Head, Jay Angene, Jr., Joseph T. Bagnara, Bry Booth, Mac C. H. Hoy, Cyril M. Kehoe, Associate Professor David E. Blish, Mary J. Hendrix, C. Ward Kissner, Albert V. Lefor, Assistant Professor Christopher A. Leadem

The department offers programs leading to Master of Science and Doctor of Philosophy degrees with a major in anatomy.

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

Degrees

Master of Science: This degree is offered in rare instances when individuals qualified for 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 one or more of these subjects, the student be allowed to audit the corresponding courses and assist in the laboratory. Acceptable subjects are anthropology, physiology, i chemistry, pharmacology, microbiology, or biological sciences. At least three semester courses must be completed in minor field.

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

502. Principles of Neuroanatomy (4) II Cl a r elements and recognized subsystems of mammalian nervous system, with emphasis general principles of neuroanatomical organ ization and their functional significance. Not open to premedical students. P. B units of biology lab. science. 401; Psych. 302, Psyc. 480 di...
Topics in Pigment Cell Biology (2) I 1990-91 (Identical with M.C.B. 557)
* Developmental Biology (3) I (Identical M.C.B. 556)
* Experiments in Developmental Biology (4) II (Identical with M.C.B. 557)
** Advanced Subjects in Endocrinology (Rpt.) I 1990-91 (Identical with M.C.B. 558)
* Endocrinology (3) II Neural and endocrine integration in the regulation of mammalian physiological functions. P, M.C.B. 103. (Identical M.C.B. 567)
be convened with 400-level course.

Topics in Neural Development (2) II 1990-91 (Identical with M.C.B. 559)
* Cellular Neurobiology (2) II 1989-90 uses on a different selected topic in the cell org of neurons and glial cells each offering. Lents read and critically discuss primary liter. P course in neurobiology or cell biol. consult with department before enrolling. (Identical with M.C.B. 584 and M.C.B. 585)
** Principles of Cellular and Molecular Neurobiology (4) I (Identical with M.C.B. 586)
* Principles of Systems Neurobiology (4) I (Identical with M.C.B. 587)
Colloquium I
Special Topics in Cell Biology (2) II [Rpt./6 units] I (Identical with C.Bio. 595D)
Introduction to the Neurosciences (2) I 1990-91 (Identical with Med. 595Y, which is home)
I. Human Gross Anatomy (8) I A comprehensive survey of the development and struct of human beings. For use in marda science, surgery, or pathology. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; consult department before enrolling.
** Microscopic Anatomy (5) I Essentials of microscopy. P, Chem. 103b, 104b, 243b, 245b; Phys. 102b; consult department before enrolling.
* Microscopic Structure (1-3) II Selected aspects of structural organization at light and electron microscopic levels of the anatomy and morph of the cells, tissues, and organs of vertebrates. P, 601, 602.
I. Gross Human Anatomy (2-6) [Rpt.] II 1989-90 (Identical with M.C.B. 553)
Neurosciences (6) II Essentials of mammalian neurodevelopment, structure and funct. P, Phys. 102b.
** Advanced Vertebrate Neuroanatomy (4) II 1989-90 (Identical with M.C.B. 552)
Anatomical Techniques (1-4) I 1989-90 Techniques to special techniques and proced of analytical anatomy. P, 601, 602; consult department before enrolling.
I. Introduction to Anatomical Literature I I 1989-90 Bibliographic research to basic anatomical references. Prior for those students planning a career in anatomy and wishing to prepare themselves for her graduate study. 3L.

Animal Physiology

Animals Sciences (ANS)

Animal Sciences, Room 326
(602) 621-1322

Associate Professors Ronald A. Allen, W. Tim A. Schurg, R. Spencer Swingle
Assistant Professors Sue DeNise, Vincent Guerrero, Mark E. Wise

The department offers programs leading to the Master of Science degree with a major in animal science, dairy science, or poultry science. Concentrations are available in animal breeding and genetics, animal nutrition, animal physiology, and meat science and muscle biology. Admission is generally dependent upon a graduate 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 admis- sion or admission as an International Special student, whichever is sooner. Support work is available in agriculture, biochemistry, chem- istry, ecology and environmental science, neurobiology and molecular biology, nutrition and food science, physiology, plant sciences, statistics, systems and industrial engineering, veterinary science and in soil and water science.

Graduate programs leading to the Doctor of Philosophy degree are administered by inter- departmental committees: Physiological Science, Genetics, and Nutritional Science.

Animal Growth and Development (2) II 1990-91 Growth and development of domestic animals, with emphasis on skeletal muscle, bone and adipose tissue growth, from the cellular level to the whole animal. P, N.F.S. 406A or Bioc. 460 or 462A.

Quantitative Genetics (3) I 1990-91 Theory of quantitative genetics including idealized populations, forces that change frequency, breeding systems, and estimation of genetic parameters in a population. P, 6 units of genetics. (Identical with Gene. 513)


Domestic Animal Endocrinology (3) I 1990-91 Endocrine regulation of growth, metabolism, and reproduction of domestic farm animals. P, 3 units of biochemistry.

Physiology of Lactation and Neonatal Development (2) II 1990-91 The anatomical and physiological mechanisms governing the process of milk secretion and neonatal development. P, 415F, VSc. 250, N.F.S. 406A.

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

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

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

Chemistry and Metabolism of Lipids (3) I 1989-90 (Identical with N.F.S. 615)

Mineral Metabolism (2) I 1989-90 (Identical with N.F.S. 622)

Ruminant Nutrition (3) I Recent findings in ruminant nutrition; the physiologic processes of digestion and absorption; importance and metabolism of rumen microflora; normal metabolism and abnormal metabolic disorders; modes of action of feed stimulants. P, Bioc. 460 or 462A.


Range Animal Research Techniques (2) II 1989-90 Techniques for determination of range animal intake, dietary composition, and grazing behavior. Range animal experimental procedures and analyses of data. 1R, 3L. Field trips.

Animal Physiology Research Techniques (2) I 1991 Introduction to selected physiological and biochemical techniques used in animal research. 1R, 3L. Open to majors only. P, Bioc. 460 or 462A.

Environmental Physiology of Domestic Animals (3) II 1991-92 Physiological, behavioral and anatomical responses of domestic animals to their environment, with emphasis on adaptive mechanisms. P, 413, 415R, 430, 3 units of general physiology/anatomy.

Anthropology (ANTH)

Anthropology Building, Room 221A
(602) 621-2716


Associate Professors Constance Cronin, Mary Ellen Moberg, John W. Olsen, Richard A. Pearson, Stephen L. Zegura
Assistant Professors Mark Nichten, Thomas K. Park

The department offers programs leading to the Masters of Arts and Doctor of Philosophy degrees with a major in anthropology. Concentrations are available in archaeology,
508. * Anthropology and Public Policy (3) II Examines the development, goals, techniques, and practices of anthropology as a policy science.

508. * Economic Anthropology (3) II Analysis of production, exchange, distribution, consumption, property, economic surplus, inheritance, and types of economic structure. (Identical with A.In.S. 530)

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

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

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

515. Cultural Ecology of Agrarian Societies in the Middle East (3) II Emphasis is on land tenure, Islamic law, irrigation and agricultural development; early Bronze Age in East, Nile valley, North Africa, and the Sahel from the Middle Ages to the present.

516. * Contemporary Indian America (3) II The history and contemporary significance of the reservation system in the life of the Native American of the United States. (Identical with A.In.S. 516)

517. * Cultures and Societies of Ancient Mexico (3) S Archaeological and ethnohistorical survey of the civilizations of ancient Mexico from earliest times to the period of the Spanish Conquest. Field trips. Fee.

518a-518b. * Scientific Illustration-Photography (2-4 — 2-4) (Identical with Ecol. 518a, b, and anthropological writing as it has moved from the paleo-Babylonian empire, with special attention to issues of sociopolitical organization. (Identical with Hist. 501)

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

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

504. * Sociology of the Southwest (3) I (Identical with Soc. 504)

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

506. * Gender and Social Identity (3) II An analysis of the social and cultural construction of gender, focusing on a different gendered society or group each semester.

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

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

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<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Description</th>
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<tbody>
<tr>
<td>602</td>
<td>Seminar</td>
<td>Intensive introduction, overview, and synthesis of major problems in the study of cultural, demographic, and ecological factors affecting microevolutionary processes in human populations. P. 665. (Identical with Gene. 666)</td>
</tr>
<tr>
<td>680</td>
<td>Survey of Linguistic Anthropology</td>
<td>Major theoretical and methodological issues in linguistic analysis. Language as a cultural code, biological foundations, universals and typology, language and social reality, textual analysis.</td>
</tr>
<tr>
<td>695</td>
<td>Colloquium</td>
<td>a. Forensic Anthropology (2) [Rpt./6 units] II 2R, 1L, P, or CR. 468 and 597b.</td>
</tr>
<tr>
<td>696</td>
<td>Seminar</td>
<td>a. Archaeology (1-3) [Rpt./3] II b. Cultural Anthropology (1-3) [Rpt./3] II c. Linguistic Anthropology (1-3) [Rpt./3] II d. Physical Anthropology (1-3) [Rpt./3] II e. Museology (1-3) [Rpt./3] II</td>
</tr>
</tbody>
</table>

**Applied Mathematics (APPL)**

Mathematics Building, Room 414 (602) 621-4664

Committee on Applied Mathematics (Graduate)

Professors David W. McLaughlin, Chairperson

(Appplied Mathematics and Mathematics, David Arnett (Physics), Bruce R. Barnett (Physics), Harrison H. Barrett (Radiology), Peter Carruthers (Physics), James M. Cushing (Committee on Applied Mathematics (Graduate)))
covering a broad spectrum of disciplines in sciences and supports cross-disciplinary research.

The committee offers programs leading to the master's and doctoral degrees, student programs are quite flexible and individually designed. Essentially, their basic structures involve a first year core of 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 core includes numerical analysis, principles of analysis, and formal methods of applied mathematics. In the problem seminar, different faculty members (primarily nonmathematicians) present in-depth analysis of problems arising in their research. A degree of sophistication 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 obtaining information about requirements and examinations should contact the committee.

Commitment. Students are currently involved with a variety of research activities, many benefited 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, difference equations, digital image processing, dynamic meteorology, ecology, economics of uncertainty, eigenvalue problems, electrical geophysics, electrometric 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 equations, interactive computer graphics, laser theory, limit theorems for probability, mathematical ecology, mathematical modeling and political violence, 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, quantum electronics, quantum mechanics, quantum optics, radio astronomy, reaction-diffusion equations, reactor dynamics, relativity, signal processing, simulation, solar energy utilization, soil mechanics, statistics, statistical mechanics, stochastic equations, structure of finite nuclei, system identification, systems theory, tensor calculus, and wave propagation.

Arabic

(See Oriental Studies)
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, print processes, ceramics, metalswork, graphic design, photography, fibers and combined media. For further information concerning this degree see Requirement for Degrees Master of Fine Arts elsewhere in this catalog.

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

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

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

Master of Arts (major in art education): 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 15 units in art education courses, including one Art 596 seminar each semester of enrollment; Art 530, and Art 633. Each student must 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 works, the Cheryl and John Kress Collection of 14th to 19th Century European art, including the surviving panels of the Relatory of Ciudad Rodrigo by Fernando Gallego; the Charles Leonard Pfeifer Collection of American art, consisting of more than 100 contemporary American paintings; the Edward Joseph Gallagher III Memorial Collection of contemporary American paintings and European, Latin American, and Oriental objects of art; and miscellaneous collections, including the University Print Collection of notable examples of various graphic arts. The Center for Creative Photography has 50,000 photographic prints, archives of negatives, correspondence and memorabilia as well as a specialized library of over 12,000 volumes. The University of Arizona Museum of Art schedules exhibitions from these collections and, from time to time, other exhibitions of general or special interest.

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


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.

Studio

505. Graduate Figure Drawing (3) [Rpt./S] II Special problems in drawing, using the classroom model and outside sources as references for personal expression. 6S.

590. Graduate Drawing Critique (3) [Rpt./S] II Individual exploration in drawing media and visual concepts. Classroom and individual critiques.
541.* Advanced Photography (3) [Rpt./1] II Current trends, philosophies and experimentation in still photography, 2R, 2S.

545.* Photographic Processes (3) [Rpt./2] I Graphic techniques and methods for the artist, 2R, 2S. P, 341, acceptance of portfolio by Portfolio Committee.

547.* Mixed Media Book (3) [Rpt./1] II Investigation of the book as a format for presenting visual material; the process of making simple books. Contemporary bookmakers will be presented. 2R, 2S. Field trips. P, 12 units of studio art credit or 6 units.

548.* Video for Artists (3) [Rpt./4] I, II Senior and graduate students utilize small format video camera and editing to extend/amplify concepts that have developed in their artistic inquiry. 2R, 2S. Field trips. P, admission by portfolio.

550. Graduate Relief Printmaking (3) [Rpt./4] I, II Relief printmaking with emphasis on individual research, personal direction and professional standards. 6S.

551. Graduate Intaglio (3) [Rpt./4] I, II Intaglio printmaking with emphasis on individual research, personal direction and professional standards. 6S.

553. Graduate Alternative Methods in Printmaking (3) [Rpt./4] I, II Nontraditional approaches to printmaking with emphasis on individual research, personal direction and professional standards. 6S.

555. Graduate Lithography (3) [Rpt./4] I, II Lithography with emphasis on individual research, personal aesthetic, and professional standards. 6S.

556. Portfolio Preparation (3) [Rpt./1] I, II Final approach to completion of portfolio. Student's portfolio is critiqued in areas of order, style, and degree of presentation to bring it to a professional level. P, 6 units of graphic design courses and approval of portfolio by Portfolio Committee.

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

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

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

571.* Advanced Jewelry and Metalsmithing (3) [Rpt./4] I, II Advanced study of the construction of jewelry and metalwork. 6S. P, 9 units of metalwork.

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

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

576.* Advanced Fibers (3) [Rpt./5] I, II Individual interpretations of concept into finished fiber work. Emphasis on intermediate fibers. 6S.

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

581.* Readings in Contemporary Art (3) I Discussion of contemporary art and artists, based upon assigned readings and slide presentations. 6S.

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

583.* Combining Media (3) [Rpt.] Individual and group projects, including collages, combination of different media, and elements from other art forms (sound, language, movement, etc.).

585. Graduate Watercolor Painting (3) [Rpt./6] I, II High level experimentation in personal expression with watercolor and related media. Demonstration and critique.

587. Sculpture Materials (3) [Rpt./21 units] I, II Exploration of materials and processes, and their compatibility with concepts. 6S.

589.* Extensions of the Figure (3) [Rpt./2] I, II Life modeling in clay over armatures and other techniques. 6S.

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

597. Workshop a. Advanced Gallery Management (3) [Rpt./2] I, II Field trips.

600. Portfolio Preparation (3) [Rpt./2] I, II Presentation of one's painting concepts and the concepts of others, citing parallel influences, research, related ideas and implications for high level concentrated student and faculty discussion.

624. Studio Photography (3) [Rpt./5] I, II Preparation of practical methodology and their importance to the student's developing body of work. Limited to art majors with photographic concentration.

671. Graduate Jewelry and Metalsmithing (6-10) [Rpt./6] I, II Graduate study in all phases of jewelry and metalwork. 12 to 20 S. P, 6 units of history or art history.

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

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

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

687. Graduate Problems in Sculpture (3) [Rpt./6] I, II Problems in sculpture. P, previous course work required. 6S.


693. Internship a. Art Museum Training (1-6) [Rpt./2] I, II Open to students concentrating in museum studies only. 6S. P, 12 units of graduate art history courses.

696. Seminar p. Curatorial Training for Archival (1-6) [Rpt./2] II, 6S. Open to students concentrating in museum studies only. 6S. P, 12 units of graduate art history courses.

698. Seminar a. History of Photography (3) [Rpt./4] I, 424a or 424b, 6S. b. Colonial and 19th-Century American Art (3) [Rpt./3] I, II Open to students concentrating in museum studies only. 6S. P, 12 units of graduate art history courses.

699. Seminar c. Archived Training for Collection of (1-6) [Rpt./2] II, 6S. Open to students concentrating in museum studies only. 6S. P, 12 units of graduate art history courses.


716. Seminar a. Art History (3) I Major intellectual advances in the visual arts developed within the past 150 years. Field trips. Open to majors only. b. Medieval Art (3-3) 512a: 11th-13th centuries. 512b: 14th-15th centuries. 512c: 16th-17th centuries. 512d: 18th century. P, 12 units of graduate art history courses.

512a-512b.* 12th-13th Century Art (3-3) Par and sculpture in Europe. 518a: 1886 to 1914. 518b: Between the World Wars. P, 6 units of history or art history. 518a is not prerequisite to 518b. 512a-512b. Pre-Columbian Art (3-3) Art of the high cultures of Mesoamerica, the focus on architecture, sculpture, par and crafts prior to European contact. 522b: A Pre-Columbian art of Central and South America with particular attention to the Andean 522a is not prerequisite to 522b. (Identical Art. 522a-522b.)

524a-524b. History of Photography (3) [Rpt.] From its invention to 1895; impact of technology on the art and culture of the 19th century. 524b: As an art medium from 1895 to 1951; 6 units of history or art history. 524a is not prerequisite to 524b.

525. Northern Baroque Painting (3) Lift ing in Belgium and the Netherlands during the 17th century. P, 118.

528. 17th- and 18th-Century Art in Italy Painting, sculpture, and architecture of Baroque and subsequent periods. P, 6 units of history or art history.

529a-529b-529c-529d.* American Art (3-3-3-3) In the United States. 529a: Colonial. 529b: 19th century art. 529c: From 1840 through 1940. 529d: Twentieth century art can art from the 1930s to recent times. Must have in art any order. P, 6 units of history or art history.

584.* Roman Art and Architecture (3) [Identical with Clas. 584]

596. Seminar

597. Seminar

598. Seminar

599. Seminar

600. Seminar

500.* Art for Exceptional Learners (3) A tailored series of guided study to provide knowledge and skills necessary for success in art education.

530. Introduction to Research in Art Ed tion (3) I Development of competent application of language, methods, and research skills used in the visual arts education as demonstrated by a scholarly ten research project.

531.* The Nature of Artistic Expression A discipline-based study of the visual providing knowledge and skills necessary for success in art education. 6S.
successful completion of the introductory graduate majors in physics, mathematics, and computer science. Applications for financial aid must be submitted by letters of recommendation. The facilities of the University of Arizona Observatories, which are associated with the Department of Astronomy, provide opportunities for student research. The 120-inch, 25-meter telescope is the Kitt Peak Observing Station, 48 miles southwest of Tucson and equipped with the Very Large Binocular Telescope. A dormitory and office building provides facilities for overnight and extended observing periods. The Steward Observatory, in collaboration with the Smithsonian Astrophysical Observatory, has constructed a 12-element Mirror Telescope equipped with a light gathering power to a conventional 176-inch telescope. The campus observatory facilities include a 21-inch reflector, the 5-inch James refractor, and the Warner and Swasey transit instrument. The 7-inch Bailey photographic reducing telescope, and the Mount Wilson 60-inch reflector, a 10-meter telescope for work at mm and sub-mm wavelengths in collaboration with the Max Planck Institute for Radio Astronomy in Bonn, Germany, the campus buildings, lecture rooms, research laboratories, staff and student offices, and technical facilities.

Instrumental equipment at the observatory stations includes a 21-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 photometric, spectroscopic, and photographic equipment. The telescopes have, as well, TV acquisition and guidance systems and systems for computer control of telescope operation and data acquisition. The observatory is developing an 8-meter telescope for planetary research on single and multiple stars; astronomical instrumentation, theoretical investigations of stellar atmospheres and interiors, the interstellar medium, star formation, and magnetohydrodynamics and general relativity applied to astrophysical problems.

502. Astronomical Instrumentation Project (3) 1989-90 Design, construction, and testing of an astronomical instrument chosen by each student under the guidance and supervision of the instructor. Regular class sessions are devoted to discussing techniques and reporting progress and problems.

503. Introduction to the Solar System (3) I 1989-90 (Identical with Phys. 503)

504. Exploration of the Solar System I (3) I (Identical with Phys. 504)

505. Interstellar Medium and Star Formation (3) II 1990-91 Derivation of physical conditions from spectral data. Ionized, atomic and molecular clouds, interstellar dust and magnetic fields. Ionization equilibrium, heating and cooling, shocks, radiation. Outflows and protostellar evolution.

518. Modern Astronomical Instrumentation and Techniques (3) I 1989-90 Radiant energy; signals and noise; detectors and techniques for imaging; interferometry, polarimetry and spectroscopy. Examples from stellar and planetary astronomy in the x-ray, optical, infrared and radio. (Identical with Phys. 518)

522. Atomic and Molecular Astrophysics (3) I 1990-91 Interpretation of astronomical spectra; basic aspects of atomic and molecular spectra and processes that enable one to infer physical processes in astronomical objects from analysis of their electromagnetic spectra. Familiarity with basic quantum mechanics is assumed.

533. Stellar Structure (3) II 1989-90 Equations of stellar structure, virial theory, energy transport, equations of state, opacities, nuclear reactions, stellar models, evolution of low and high mass stars, observational tests, rotation and magnetic fields, binary evolution.

540. Structure and Dynamics of Galaxies (3) I 1990-91 Observational properties of galaxies; star clusters, kinematics, stellar populations, the dynamical and gravitational properties of galaxies. Structure of our own galaxy. Dynamics of stellar systems: equilibria, instabilities, internally and externally driven evolution.

541. Relativistic Astrophysics and Cosmology (3) II 1990-91 The structure, origin and evolution of the physical universe from theory and observations of systems outside our own galaxy. Relativistic cosmology; galaxy evolution and clustering; active galaxies and quasars; the microwave background; galaxy formation; the hot big bang; and physics of the early universe. (Identical with Phys. 540)

545. Stellar Atmospheres (3) I 1989-90 Radiative transfer, gray atmosphere, opacity, line formation, non-LTE, curves of growth, stellar hydrodynamics, planetary applications. (Identical with Phys. 545)

551. Satellite and Planetary Perturbation Theory (3) II (Identical with Phys. 551)


556. Electrodynamics of Conducting Fluids and Plasma (3-3) 1990-91 (Identical with Phys. 556b)

557. General Relativity and Cosmology (3) II 1989-90 (Identical with Phys. 557)


568. High Energy Astrophysics (3) I 1989-90 Radiation mechanisms, charged particle radiation, charged particle acceleration, pulsars, black holes, accretion disks, X-ray binaries, gamma-ray sources, radio galaxies, active galactic nuclei. (Identical with Phys. 569 and Phys. 582)


589. Topics in Theoretical Astrophysics (3) I (Identical with Phys. 589)

Atmospheric Sciences (ATMO)

Physics-Atmospheric Sciences Building, Room 542
(602) 621-6831

Professors E. Philip Kreider, Head, George A. Dawson, Robert L. Galil, Benjamin M. Herman, A. Richard Kassander, Jr. (Emeritus), Joann A. Reagan (Electrical and Computer Engineering), Richard M. Schott, William D. Sellers, Dean O. Staley, Sean A. Twomey Associate Professor Kenneth C. Young
Assistant Professors Eric A. Betterton, Joseph A. Zehnder

The Department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in atmospheric sciences. Research is offered through the Institute of Atmospheric Sciences. Applications from students in areas such as radiative transfer, remote sensing, atmospheric aerosols, atmospheric chemistry, cloud and precipitation physics, lightning and atmospheric electricity, atmospheric dynamics, mesoscale meteorology, and the modeling of global climate.

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

Degrees

Master of Science: 30 units of graduate work, including 541a-541b, 551a, and three 500- to 600-level courses chosen as required. All candidates must submit a thesis or a manuscript which has been judged by the student's committee to be acceptable for publication. A final approved scientific journal and pass a comprehensive written examination in the major field.

Doctor of Philosophy: In addition to the College of Engineering, the Department of Atmospheric Sciences and Oceanography requires the candidates to demonstrate a reading knowledge of a foreign language approved by his or her committee.

521.* Physical Climatology (3) II Heat and water balances of the earth-atmosphere viewed from both the local and global scales; paleoclimatology and theories of climatic change and climate change. P. 171.

530. Micrometeorology (3) I 1989-90 Theoretical aspects of atmospheric turbulence, including theories of laminar flow, turbulent flow, the mechanical energy equations, and the shear stress and the wind profile. P. 441b.

535. Air/Sea Interactions (3) I 1990-91 Physical characteristics of the oceans; the dynamics of ocean currents and their interactions with the atmosphere; El Niño and other teleconnections between the oceans and the atmosphere. P. 300.

541a-541b.* Dynamic Meteorology (3-3) Thermodynamics and its application to planetary atmospheres, hydrostatics, fundamental concepts and laws of dynamic meteorology. P. Phys. 121; Math. 254.

554. Physics of High Atmospheres (3) II 1989-90 (Identical with Phys. 544)


551a-551b.* Physical Meteorology (3-3) Introduction to atmospheric physics, including atmospheric radiation, fluid mechanics, aerosol physics, cloud physics, and atmospheric electricity. P. Phys. 121; Math. 254.

560. Aerosol Science (3) I 1989-90 Physics, chemistry, mechanics, and optics of atmospheric aerosol particles. Topics include formation, dynamics, nucleation and growth, coagulation, scattering and absorption of radiation, deposition and aerosol technology. (Identical with E.C.E. 560).

565.* Mesoscale Meteorology (3) II 1989-90 Description and dynamics of weather systems of the mesoscale. Topics may include fronts, thunderstorms, gravity waves, lake effect storms and sea breezes, P. 300.

571.* Synoptic Analysis (3) I 1990-91 Principles of meteorological analysis, including surface and upper-level charts, cross-sections, kinematic analysis, structure of the troposphere and lower stratosphere and synoptic dynamic diagrams. 1R, 6L; P. CR, 300 or 441a

572.* Weather Forecasting (3) II 1990-91 Techniques for weather forecasting and actual forecasting experience; advanced synoptic analysis. 1R, 6L; P. 411b.

585. Tropospheric Chemistry (3) I 1989-90 A study of tropospheric chemistry, with emphasis on the controls and feedbacks influencing the major constituents, the cycles of the minor constituents, methods of measurement, and applications.


683. Principles of Atmospheric Remote Sensing (3) II 1990-91 For remote sensing applications, mathematical methods are developed to infer the physical properties of the atmosphere. Techniques using optical and microwave frequencies are examined for their information content. P. 656b, Math. 254. (Identical with E.C.E. 683).

Bilingual/Bicultural Education
(See Language, Reading and Culture)

Biochemistry (BIOC)

Biological Sciences West Building, Room 445 (602) 621-5770

Professors Michael A. Wells, Head, H. E. Carter (Emeritus), David W. Mount (Molecular and Cellu-lar Biology), Martinez Hewlett (Molecular and Cellular Biology), John W. Little, Marc Tischler

Assistant Professors Danny L. Brower (Molecul- lar and Cellular Biology), James F. Dett erage, Carol Dieckmann, Elizabeth Vieira

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 Master of Science and Doctor of Philosophy degrees. Except in unusual circumstances, however, the department will only admit graduate students whose stated objective is the Doctor of Philosophy degree. The department also offers undergraduate instruction in programs of the Colleges of Agriculture, Arts and Science, and Medicine, and undergraduate Bachelor Science and Bachelor of Arts degrees in Biochemistry.

Research areas in which graduate study may be pursued cover most modern aspects of biochemistry including electron and X-ray diffraction; electron tomography; protein structure and function; biochemical genetics; molecular biology and biochemistry; gene expression and regulation; genomics, proteomics, and functional genomics, and cell surface biochemistry; muscle biochemistry and cell motility; hormone action and signaling; and protein, lipid and nuclear metabolism.

501. Medical Biochemistry (5) I Comprehensive treatment of general biochemistry, oriented towards human biology, with emphasis on basic concepts; protein and nucleic acid structure and function; metabolism of lipids and carbohydrates and inorganic and organic metabolism and closely related topics. Chem. 103b, 104b, 241b, 245b; Phys. 102b, 202b.

502. Intermediate Medical Biochemistry (5) An intermediate treatment of several general biochemistry including metabolism and nutrition, genetics and membranes. Design to build on the student's prior knowledge of biochemistry. Consult department before enrollment. P. 462a-462b.


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

561a-561b. Introduction to Biochemical Literature (1-3) I 1990-91 Discussion of the literature in biochemistry aimed at helping the student evaluate and report the published literature. I Seminar: 3 units. Final exam required. P. 462a-462b. 561a is not prerequisite to 562a. P. 462a, 462b.

562a-562b.* Biochemistry (3-4) Introduction to the properties and metabolism of protein
lice acids, enzymes carbohydrates and ds. Designed primarily for majors and
or in the biochemistry and biology
Chem. 241b, CR. 325, 325. (Identical with
m. 562a-562b and Bio.
1. Biochemistry Laboratory (2) I Introdu-
tion to experimentation with biochemical
items, processes and components of bio-
tochemical importance 1R 51 L. P. 460 or 462a.
1. CR 462b.
1. Enzymes (3) I 1990-91 Advanced consid-
eration of enzyme structure and function P.
2a. Chem. 480b. (Identical with Chem. 565.)
1. Nucleic Acids (3) II Chemistry, structure,
function of nucleic acids replication, tran-
slation, gene organization, regulat-
ion of gene expression and organelle nucleic
acids. Both procaryotic and euchromatic systems
be considered. (Identical with Gene 568,
2b. 568 and N.F.S. 568.)
0. Molecular Biology of the Cell Mem-
brane (3) I 1990-91 Cell membrane functions
regulating biosynthesis, structures of membrane
components, importance of cell communica-
tion, differentiation, adhesion, immune
response, and cancer. Discussions on the use
monoclonal antibodies, recombinant DNA
technology, and DNA transfections in studies
the biology of the cell membrane (Identical
with Chem. 570 and M.C.B. 570.)
2. Metabolic and Hormonal Control of Cell
(Course) 11990-91 Advanced treatment of
biological aspects of metabolic regula-
and hormone action. P. 462a-462b and 575
consult department before enrolling (Ident-
ical with Chem. 570.)
3. Recombinant DNA Techniques (3) II
orical with M.C.B. 573.)
4 by be converted with 100-level course
5. Biochemical Techniques (3) I Survey of
irrelevant techniques used in biochemical
search including methods used to study pro-
teins, nucleic acids, membranes and metabo-
lics. P. 462a-462b. (Identical with Chem. 575.)
6. Biophysical Techniques (3) I Survey of
relevant physical techniques used in biochem-
ical research including solution properties of
acromolecules, optical spectroscopy, mag-
netic resonance and X-ray and electron diffrac-
tion. P. 462a-462b and Chem. 480a-480b.
Identical with Chem. 575.
18. Principles of Cellular and Molecular
(eurobiology) (4) I (Identical with Nsc. 588.
15. Colloquium
b. Topics in Electron Microscopy (2) 
Rpt. 2
1989-90 II (Identical with M.C.B. 595b,
which is home)
13. Chemistry of Food Proteins (3) II
899-93 (Identical with N.F.S. 665.
11. Introduction to Biochemical Research
-2) I Supervised research experiences in the
is of individual faculty members. 3 or 6 L.
pen only to first-year majors. P, CR.
15a-516b.
16. Seminar
a. Biochemistry I (1-3) I
b. Biochemistry II (1-3) II
0. Research (1-16) Yr.
11. Medical Biochemistry (5)
24. Intermediate Medical Biochemistry (5) I
Preceptorship
a. Biochemistry (3-12) [Rpt. '12 units]

biological Sciences

graduate work and research in the biological
sciences are carried out in a number of dif-
terent locations at the University of Arizona. For
the information concerning degree programs see
the following headnotes elsewhere in this
catalog.

Anatomy
Animal Sciences
Biochemistry
Biological Chemistry
Cancer Biology
Ecology and Evolutionary Biology
Entomology
Genetics
Microbiology and Immunology
Molecular and Cellular Biology
Neuroscience
Nutritional Sciences
Pharmacology and Toxicology
Physiological Sciences
Plant Pathology
Plant Sciences
Toxicology

In addition, a number of other departments
offer graduate work, a component of which
is related importantly to the biological sciences.
Among these are:

Engineering (Biomedical option)
Exercise and Sport Sciences
Nursing
Nutrition and Food Science
Pharmaceutical Sciences
Pharmacology
Practice
Speech and Hearing Sciences

Biomedical Engineering
Electrical and Computer Engineering

Comm. on Biomedical Engineering

Professors Joseph F. Gross (Chemica Engi-
neering, Physiology), Chairperson Peter H.
Barrios (Optical Sciences, Pathology), Paul
C. Johnson (Physiology), Murray A. Katz
(Internal Medicine, Physiology), Kenneth C.
Myrea (Electrical and Computer Engineer-
ing), Robert Roemer (Aerospace and
Mechanical Engineering)
Associate Professor Bruce Simon (Aerospace
and Mechanical Engineering)

Biomedical engineering can be defined as a
multidisciplinary in which physical scientis
ts and engineers interact with life scientists and
physiologists to solve problems ranging from basic
biomedical engineering research to appli
cations in clinics and health care delivery systems. The
University Committee on Biomedical Engineer-
ing coordinates options available to students in
the College of Engineering and Mines.

Graduate students working toward the Mas-
ter of Science or Doctor of Philosophy in an
engineering department may select courses and
research topics in biomedical engineering as
part of their minor programs. No biomedical
engineering degrees are offered.

Courses available in biomedical engineering are
offered through engineering and other
departments and include A.M.E. 585; E.E.C.
515, 517; Ch.E. 585, 586; and S.I.E. 581. Addi-
tional courses in biomedical engineering are
being developed, and supporting course work
in the life sciences is also available. Collabora-
tive research projects permit the student to par-
ticipate in interdisciplinary associations which
can enhance progress in the fields of biology,
medicine, and engineering. Individual pro-
grams are determined by the student and an
engineering department advisor.

For additional information contact Dr. J.F.
Gross (Chemical Engineering), Chairperson,
Committee on Biomedical Engineering, or Dr.
K.C. Mylrea (Electrical and Computer Engineer-
ing), Director, Clinical Engineering. Also see
Engineering.

Botany
(See Ecology and Evolutionary Biology)

Business Administration (BAD)

BPA Building, Room 230
(602) 621-2386

Committee on Business Administration

Professors William B. Barrett (Vice Dean), Chair-
person, Gerald O. Bernwag (Finance and Real
Estate), Dipankar Chakravarti (Marketing),
William L. Felix, Jr. (Accounting), Roy E.
Marston (Management Information Systems), Jay
F. Nunamaker, Jr. (Management Information
Systems)

Associate Professors John Z. Drabicki (Eco-
nomics), Gregory B. Northcraft (Eco-
nomics)

The committee offers programs leading to the
Master of Business Administration and the Doc-
tor of Philosophy degrees with a major in busi-
ness 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 informa-
tion concerning this degree see Requirements
for Masters’ Degrees Master of Business
Administration elsewhere in this catalog.

Doctor of Philosophy: The degree program
is interdisciplinary and draws heavily on the fields
of mathematics, economics, and the behavioral
sciences, as well as the knowledge of a spe-
cific management discipline.

Candidates must have a bachelor’s degree
and proficiency in mathematics at the level of
Math. 125a-125b. Individual programs may vary
to allow for differing backgrounds and to
accommodate different special interests.

Courses are chosen with the approval of the
major and minor advisors to provide a strong
theoretical and methodological background for
research in the candidate’s particular disci-
pline. The program requires a major in one of
the concentration fields available in the college:
accounting, decision sciences, finance, man-
agement and policy, management information
systems, and marketing. Minors are selected in
a field which complements the major area of
emphasis.

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

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

- Fall admission is April 1 and for spring admission, November 1.
- All students are required to complete 13 units of core courses specified by the committee and which include: 3 units of Cancer Biology, 3 units of Environmental Carcinogenesis, 2 units of Cancer Cell Biology, 3 units of Cancer Genetics and Cytogenetics, and 2 units of Cancer Biology Seminar.

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### 551. Environmental Carcinogenesis
(3) I 1990-91 (Identical with R.Onc. 551)

### 555. Cancer Biology
(3) II 1990-91 (Identical with M.S.E. 555)

### 556. Colloquium
- d. Special Topics in Cell Biology (2) [Rpt/6 units] II (Identical with Anat. 595d, M.C.B. 595d, and R.Onc. 595d)

### 558. Seminar
- f. Cancer Genetics and Cytogenetics (3) I 1989-90 P, undergraduate genetics course or equivalent with Gene. 595f, Mirc. 595f, M.C.B. 595f

### 681. Introduction to Cancer Biology Research
(2) II S 1990-91 Supervised research experience in the laboratories of individual faculty members.

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**Cellular and Developmental Biology (See Molecular and Cellular Biology)**

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### Chemical Engineering (CHE)

**Geology Building, Room 120** (602) 621-2591

Professors Gary K. Patterson, Head, Milan Bier, Joseph F. Gross, Richard M. Edwards (Emeritus), Thomas W. Peterson, Alan D. Randolph, Thomas R. Rehm, Jost O. L. Wendt, Donald H. White

Associate Professors William P. Cosart, Farhang Shadam

Assistant Professors Heriberto Cabezas, Simon P. Hanson

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### 521. Advanced Engineering Analysis
(3) II 1990-91 Process modeling techniques, residence time distribution theory, dynamics of distributed parameter systems, nonlinear parameter estimation. P, 402

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### 505. Advanced Chemical Engineering Transport Phenomena
(3) I Momentum, energy and mass transport in continua, solution of multi-dimensional laminar flow problems, turbulence, boundary layer theory. P, 305.

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### 506. Advanced Chemical Engineering Thermodynamics
(3) I Advanced applications of First and Second Laws, nonideal gases and liquids and their mixtures, principles of chemical equilibrium, and molecular theory. P, 306.

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### 514. Particle Size Analysis
(3) II 1989-90 Dispersed-phase dynamics, population balance functions, particle growth kinetics, birth-death functions, phase space particle distributions, suspended-phase reactors, crystalization, and comminution.

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### 520. Advanced Biomedical Engineering

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### 523. Advanced Chemical Engineering Mass Transfer
(3) I 1989-90 Principles of mass and momentum transfer in physical systems utilizing surface renewal, and boundary layer transport concepts. P, 505.

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### 526. Advanced Biomedical Engineering

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### 527. Advanced Chemical Engineering Mass Transfer
(3) I 1989-90 Principles of mass and momentum transfer in physical systems utilizing surface renewal, and boundary layer transport concepts. P, 505.

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### 528. Advanced Solar Engineering
(3) II I 1989-90 Algorithms for analog and digital computer design and applications. P, 710.
Chemistry (CHEM)
Old Chemistry Building, Room 227
(602) 621-2809


Associate Professors Peter F. Bernath, Michael F. Burke, Jeanne E. Pemberton, John V. Rund, G. Krishna Vemulapalli

Assistant Professors Ludwik Adamowicz, Steven W. Buckner, Daniel P. Dohme, Eugene A. Marsh, Jr., Robin L. Polt, Mark A. Smith, David E. Wigley

The department offers programs leading to the Master of Arts, Master of Science, Master of Education, and Doctor of Philosophy degrees with a major in chemistry. Concentrations are available in analytical, biochemistry, inorganic, organic, and polymer, and physical chemistry; and can include chemical physics, materials science, optical sciences, and several other interdisciplinary fields.

Prospective students should write to the Office of Academic Affairs in the Department of Chemistry for information and brochures about the variety of research programs, the faculty involved, the facilities available, and the guidelines for the graduate program in chemistry. Teaching assistantships and/or fellowship support are available for all first-year graduate students. Research support is also available for qualified graduate students.

New students are assisted and advised by the departmental Graduate Study Committee until they are prepared to select a research program, and a research advisor. The committee administers examinations for all new students during the week before registration each semester. These examinations cover various branches of chemistry, and the results are used to help students plan an appropriate graduate program.

Degrees
Master of Arts: Students who plan to teach chemistry in secondary schools will find this program adapted to their needs. A thesis is required but, at the discretion of the department, it need not embody the results of original laboratory research. All students must pass a final oral examination.

Master of Science: A thesis based upon original research is required. All students must pass a final oral examination. More information may be obtained from Master of Education elsewhere in this catalog.

Doctor of Philosophy: The Doctor of Philosophy with a major in chemistry is primarily a research degree. The selection of courses is tailored to the individual student's needs and interests according to the guidelines available from the Office of Academic Affairs in the Department of Chemistry. The minor work may be specified with the Department of Chemistry. 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. A dissertation based upon original laboratory research is required. All students must pass a preliminary examination and a final oral examination.

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

502. Intermediate Organic Chemistry (3) I
Survey of the principal classes of organic reactions. P. 241B or 242B.

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

504. Intermediate Inorganic Chemistry (3) I
Principles of modern inorganic chemistry, including synthesis, structure, physical properties, and reactivity of inorganic compounds and materials.

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

512. Advanced Inorganic Preparations (2-4) II Modern inorganic syntheses, including instruction in the use of high pressure, temperature, and vacuum techniques and in the manipulation of unstable compounds. 6 to 12 L.

517. Structural Chemistry (3) II 1990-91 Introduction to the determination of structures of complex molecules by X-ray crystallography; the evaluation of structural information; current topics in structural chemistry. 2R, 3L.

520. Advanced Analytical Chemistry (3) II 1989-90 Elemental analysis, separation processes, kinetic and thermal methods of analysis. P. 480B.

521. Advanced Instrumental Analysis (3) I Techniques of spectrophotometry, emission spectrometry, chromatography, electroanalysis, principles of instrumentation and data acquisition at an advanced level. P. 424, 480B.

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

525. Organometallic Chemistry (3) I 1989-90 Theory underlying the application of organometallic reagents in chemical analysis. P. 523.


528. Advanced Instrumental Laboratory (2) I Laboratory experiments in spectrophotometry, emission spectrometry, chromatography and electroanalysis. P. CR 521.

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

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

541. Mechanisms of Organic Reactions (3) I Detailed analysis of the factors which influence the rates and courses of organic processes. P. 241B, 480B.

543. Structural Organic Chemistry (3) II Structure determination of organic molecules. P. 241B, 480B.

560. General Biochemistry (5) I (Identical with Bioc 560)

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

562a-562b. Biochemistry (4-3) (Identical with Bioc 562a-562b)* *May be counted with 400-level course.

565. Enzymes (3) II 1990-91 (Identical with Bioc 565)

570. Molecular Biology of the Cell Membrane (3) I 1990-91 (Identical with Bioc 570)

572. Metabolic and Hormonal Control of Cell Function (3) II 1990-91 (Identical with Bioc 572)

575. Biochemical Techniques (3) I (Identical with Bioc 575)

576. Biophysical Techniques (3) I (Identical with Bioc 576)

580. Introduction to Quantum Chemistry (3) I An introduction to quantum mechanics, with applications to atomic structure and spectra, the nature of chemical bonding and molecular structure. P. 480B.

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

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

583. Chemical Kinetics (3) I 1989-90 Classical and modern techniques in studies of chemical reaction. P. 480B.

584. Practical NMR Spectroscopy (3) I The basic principles of Fourier transform nuclear magnetic resonance (NMR) spectroscopy, the design and application of spectrometers and the spectra. P. a course in physical chemistry.

587. Introduction to Molecular Spectroscopy (3) II Modern molecular spectroscopy including rotational, vibrational, and electronic spectroscopy and their various combinations. P. 480A-480B or consult department before enrollment.

593. Chemical Mechanisms and Inorganic Reactions (3) II 1989-90 An examination of the techniques and reasoning used in assigning reaction mechanisms. P. 510b.

594. Inorganic Nanomeric Compounds (3) II 1990-91 Compounds containing carbon-based metal bonds, with emphasis on those of the transition elements, and the determination of their structures. P. 410.

615. Coordination Chemistry (3) I 1989-90 Selected topics in the area of coordination compounds of transition metals, with particular emphasis on ligands, and symmetry aspects of the spectra of the transition metal complexes and their magnetic behavior. P. or CR, 510b.

616. Chemistry of the Main Group Elements (3) I 1990-91 Theory, structure, and chemistry of the group III, IV, and V elements. The chemistry of the hydrides, particularly of boron, are emphasized. Current theoretical approaches
and experimental techniques are stressed. P. 577.

618. Computation in Chemistry (3) [Rpt./I] II 1990-91 State-of-the-art computational methods in chemical research, including approximate and exact electronic structure methods, molecular mechanics, and modeling techniques. 2R, 3L, P, consult department before enrolling.

640. General Organic Synthesis (3) II Theorv and practice of molecular design and construction as applied to synthesis of complex organic molecules. P. 540 or consult department before enrolling. 642a-642b. Polymer Chemistry (3-3) I II 1989-90 Synthesis, stereochemistry, and mechanisms of formation of high polymers. 642a: Condensation and ring-opening polymers. 642b: Vinyl polymers. P. 540. 642a is not a prerequisite to 642b.


645. Chemistry of Natural Products (3) II 1990-91 Isolation, structural elucidation, total synthesis, metabolic and pharmacological importance of natural products. P. 540.

680. Quantum Chemistry (3) II Principles of quantum mechanics with applications to the properties of molecules. P. 580.


687. Molecular Spectroscopy (3) I 1989-90 Applications of optical and infrared spectroscopy to the interpretation of the spectra of molecules of chemical and biological interest. P. 580.

691. Precipitation
   a. College Teaching (1) [Rpt./2 units] II S
   b. Chemistry Course Development (1) [Rpt./3 units] II S
   c. Professional Service (1) I II S

Note: A combination of 691 a, b, or c may be taken up to a total of 6 units.

695. Colloquium
   a. Chemical Research Opportunities (1) I
   b. Exchange of Chemical Information (1-3) [Rpt./7 units] II S

696. Seminar
   a. Analytical Chemistry (1-3) [Rpt./8 units] II
   b. Inorganic Chemistry (1-3) [Rpt./8 units] II
   c. Organic Chemistry (1-3) [Rpt./8 units] II
   d. Physical Chemistry and Chemical Physics (1-3) [Rpt./8 units] II

697. Workshop
   a. Chemical Instruments (1-3) I

Child Development and Family Relations
(See Family Studies under Family and Consumer Resources)

Chinese
(See Oriental Studies)

Civil Engineering and Engineering Mechanics (CE/EM)
Civil Engineering Building, Room 206
(602) 621-2266

Professors Chandrakant S. Desai, Head; Carl J. Buckman (Emeritus); Dinshaw N. Contractor, Donald A. DiDorso, Chintya Haldar, David J. Hall (Emeritus), Simon Ince, Rudolf A. Jimenez, James D. Krieger (Emeritus), Emmett M. Laursen (Emeritus), Allan J. Mallick, Haaren A. Miklofsky (Emeritus), Richmond C. Neff (Emeritus), Robert J. Phillips, Ralph M. Richard, Raymond A. Sierka, Ernest T. Smerdon, Terry Triffett

Associate Professors Gary L. Amy, Munirah Shahd Surat, R. Eshani, Donald M. Hawes (Emeritus), Edward A. Nowatzki, Margaret S. Petersen, Robert H. Wortman

Assistant Professors Robert G. Arnold, Curtis W. Bryant, Panos D. Christos, Patsy D. Ksousis, Tribikram Kundu, Bruce E. Logan, Hamid Saadatmanesh

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in civil engineering and engineering mechanics. Work is directed toward research and professional development in such areas as engineering mechanics, engineering materials, regional development and urban planning, highway engineering, hydraulics and flow mechanisms, environmental engineering, geomechanics, geotechnical engineering, water resources, structural engineering, and transportation. Certain inter-disciplinary programs are offered by combining courses from various areas of the program. For further information concerning these options see Engineering elsewhere in this catalog.

Degrees

Master of Science: A thesis or engineering report is required. At the option of the department, the degree may be awarded, without a thesis or engineering report, to candidates for the Doctor of Philosophy degree who have passed the preliminary examination.

Doctor of Philosophy: A minor field may be selected from architecture, chemistry, geology, mathematics, mechanical engineering, materials science and engineering, mining engineering, nuclear engineering, physics, or systems engineering, or from within the Department of Civil Engineering and Engineering Mechanics. Still other fields are available as minors with the approval of the head of the department.

Civil Engineering (CE)

In addition to the courses listed below, the faculty of the Department of Civil Engineering and Engineering Mechanics is prepared to offer temporary special courses, subject to faculty availability and student interest: public works planning and engineering, construction engineering, hydraulics, environmental engineering, soil mechanics and foundations, project management, ocean engineering, and construction engineering.

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


503. Subsurface Fluid Dynamics (3) I (Identical with Hydr. 503)

504. Numerical Methods in Subsurface Hydrology (4) II (Identical with Hydr. 504)


521. River Engineering (3) II River geology, morphology and recognition of natural rivers, canyon flow, water resource development, impacts of river engineering works.

524. Hydropower Engineering (3) II Hydrologic analysis, evaluation of site potential, bine selection, power plant civil works, project feasibility. P. 322, 423 or 523.

525. Water Quality Management (3) I Determination of water quality models, applications of models with emphasis on water quality management functions. Application and modifications of Streeter-Phelps techniques for predicting oxygen deficiency in streams. P. 321. (Identical with W.R.A. 525)

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


533. Plastic Analysis and Design (3) II Material and member behavior to full plasticity, redistribution of forces, plastic design of concrete beams and frames. Influence of axial shear forces; deflections and rotations; plasticity limitations. Shakedown analysis. P. 346 consult department before enrolling.

538. Computer-Aided Geometric Design (3) (Identical with A.M.E. 536)

537. Prestressed Concrete Structures (3) Behavior, analysis, and design of static and service limit state concrete structures. P. 337.

540. Foundation Engineering (3) II Settling capacity of shallow foundations, design of footings and pile foundations, calculations on footings, pile foundations. P. 337.


542. Soil Stabilization (3) II Purpose of stabilization; unique characteristics of stabilization. P. 344.

544. Soil Structure Interaction (3) I Behavior under load, design of interaction between soil and structure, interaction between soil and structure. P. 345.


548. Numerical Methods in Geotechnical Engineering (3) I Brief statements and applications...
is of numerical methods based on closed
numerical schemes, finite element and
boundary element methods for problems
involving solid structure interaction such as
piles, slabs on grade, and contiguous
foundations. Finite element solutions
are applied to environmental systems.
5. Water quality maintenance; physical, chemical
and biological aspects of solid waste and
wastewater treatment processes. Concentration of important
materials, toxic and hazardous wastes. Both traditional
treatment trains can be synthesized to control
emissions from which treatment strategies and process
design principles in that subject area. 3L. CR, 3L.
6. Environmental Air Pollution (3) I Air
pollution sources and pollutant control, with
special consideration of the meteorological,
urban, rural, industrial, and health aspects.
578. Environmental Air Pollution (3) I Air
pollution sources and pollutant control, with
special consideration of the meteorological,
urban, rural, industrial, and health aspects.
576. Fundamentals of Industrial Hygiene (3)
I (Identical with O.S.H. 586)
587. Advanced Industrial Hygiene and
Safety (3) I (Identical with O.S.H. 587)
596. Seminar II a. Sanitary and Environmental Engineering
(1-3) II b. Geomechanics/Geophysics (1) (Rpt./2) II
(Identical with E.M. 596b)
613. Theory of Elastic Stability (3) II Bending
and buckling of prismatic bars, beams, rings,
curved bars, thin shells, and thin pates under
axial and lateral loading. P, 340.
614. Traffic Engineering (3) I Methods for
the efficient and safe operation of transportfacili-
ties through analysis of capacity, safety, speed,
ranking, and volume data. P, 360.
615. Airport Planning and Design (3) II
cation, analysis and design of airports and
port facilities, including aircraft characteris-
tics, site selection, configuration, capacity,
616. Project Planning and Modeling (3) II
Feasability systems in contemporary plan-
ing, including operation of social, environ-
mental and physical constraints; study of
nereal and special purpose manual and
computer-based simulation and gaming as an
introducing and planning tool. P, senior stand-
ing in civil engineering or consult with depart-
ment. (Identical with Ping. 565)
617. Urban Transportation Planning (3) II
Transportation planning in relation to urban
development; techniques and procedures for
veloping long-range regional plans. P, 360 or
department before enrolling. (Identical
with Ping. 567)
618. Water Quality Control (3) II Aspects of
water quality management; physical, chemical
d biological factors in water and wastewater
treatment and disposal; purification. 2L. 3L.
Credit available for nonmajors only. P, 103b.
(Identical with Hyd. 571 and
M, 571)
619. Chemical Transport in Environmental
Principles of bacte-
rial physiology including morphology, metabo-
ilism, and cell growth. Applications of importance
to water treatment and environmental quality. P.
370, or consult with department.
620. Introduction to Hazardous Wastes (3) I
Management of environmental aspects of solid hazardous waste
and disposal. P, 370 or 471 or consult
department before enrolling.
621. Sediment Transportation (2) I Erosion,
turbation and deposition of sediments by
flowing water; sediment properties and their
analysis. Laboratory work and field work. P.
622. Open-Channel Flow (3) I Continuity,
energy and momentum principles applied to
steady and unsteady flow in open channels,
channel controls, floods, routing, and
models. P, 322.
623. Flow through Hydraulic Structures (3) II
Erosion, control, and supercritical flow
through culverts, bridges, spillways, stalling
basins, transitions, bends; hydrologic effects on
inflow, pumps and turbines. P, 322.
624. Planning and Design of Multipurpose
Water Resources Projects (3) II Design of
water resources systems for surface water sup-
ply, flood control, hydropower and navigation,
either as single purpose or as multipurpose
projects; brief review of environmental, eco-
nomic and legal aspects. Field trips. P, 321, 423
or 523.
625. Reinforced Concrete Members (3) I In-
elastic behavior of beams and columns; short-
and long-term beam deflections; combined
bending, shear, and torsion in beams; behavior
of beams loaded under distributed load; design of
depth of columns and connections and shear walls.
P, 437 or departmental approval.
626. Soil-Structure Interaction (3) I 1989-90
Examination of soil behavior and interaction of
form and numerical solutions, beams, axially
and laterally loaded piles and walls, wave
equation for piles, group piles, slabs on
deformable media. P, 640 or 641 or consult
department before enrolling.
627. 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
628. Advanced Foundation Engineering (3) II
Shallow foundations, pile foundations, sheet-
629. Engineering Characteristics of Soil (3)
I Advanced theories of mechanical and physical
aspects of soil. Lab testing including index
parameters, compaction, consolidation, shear
strength; introduction to Geotechnical methods.
Laboratory, pole testing, physical and plas-
ticity aspects. 2L. 3L. P, 640.
630. Physicochemical Soil Behavior (3) I
1989-90 Methods of physicochemical principles in soil engi-
neering, including basic clay mineralogy,
labeling soils, particle size analysis, laboratory
and field testing, including X-ray diffraction, differential thermal
analysis, electron microscopy. 2L. 3L. P, 340.
646. Soil Dynamics and Machine Foundation-
ization (3) 1989-91 Advanced methods of compaction
of soils, dynamic soil properties, machine foundation design. P.
640.
648. Constitutive Laws for Engineering
Materials (3) I 1989-90 Fundamentals of continuum mechanics strain, stress and
non-linear behavior. Laboratory testing including
hyperelasticity, hypoelasticity, rate type models,
plasticity, hardening, volume change and
dilatancy, softening, inherent and induced
anisotropy, laboratory testing and implementa-
tion. P, E.M. 505, 603, or consult department before enrolling. (Identical with Ping. 647)
649. Probabilistic Methods in Geotechnical
Engineering (3) II 1989-90 Randomness and
1990-91 Probability, properties of probability distribu-
tion, random walk, normal distribution, analysis
of flow systems, probabilistic theory of stress
distribution, variability of functions, uncertainty
and material parameters, reliability applications in
slope stability, bearing capacity, stochastic
651. Structural Design of Flexible Pave-
ments (3) I Analysis of loads, stresses, material
capabilities, and evaluation of currently
developing theoretical and practical design, construction
and maintenance of pavements. P, 340, 361.
652. Structural Design of Rigid Pavements (3)
I Analysis of loads, stresses, material
capabilities, and evaluation of currently
developing theoretical and practical design, construction
and maintenance of these pavements. P, 340, 361.
654. Transportation Economics (3) I Eco-
nomic analysis of transport projects, including
urban and rural roadways, control systems, and
mass transit; discussion of environmental and
financial factors. P, 456 or 563.
655. Quick Response Transportation Planning
Methods (3) I 1989-90 Quick response transportation tools for
projecting future transportation trends, policy analysis, and strategic planning in
the urban setting. (Identical with Ping, 665)
656. Highway Geometric Design (3) I
1990-91 Geometric design of urban
highways, with emphasis on analysis and design for
safety. P, 456 or 563.
657. Traffic Operations and Safety (3) II
1990-91 Traffic operations of control devices for
street and highways, design of traffic control
systems, analysis and management of highway
trafic, evaluation of safety. P, 456 or 563.
659. Urban Public Transportation Systems
(3) I 1990-91 Development, operation, manage-
ment, financing, evaluation and travel demand estimation for urban public transportation sys-
tems. (Identical with Ping. 676)
673R. Advances in Water and Waste Recla-
mination and Reuse (3) II Theory, application,
evaluation of currently developing tech-
niques in water and waste reclaimation and
reuse. P, 67SR.
673L. Advanced Water-Wastewater Treat-
ment Laboratory (1) I Experiments in physical-chemical treatment of water and
wastewater designed to illustrate treatment design principles in that subject area. 3L. CR,
673R. Advances in Water and Waste Recla-
mation and Reuse (3) II Theory, application,
evaluation of currently developing tech-
niques in water and waste reclaimation and
reuse. P, 67SR.
673L. Advanced Water-Wastewater Treat-
ment Laboratory (1) I Experiments in physical-chemical treatment of water and
wastewater designed to illustrate treatment design principles in that subject area. 3L. CR,
ter and anaerobic digestion designed to illustrate treatment principles. 3L, CR. 675R.


678L. Water Treatment and System Laboratory (1) Experiments in advanced water treatment developed to illustrate design principles in the potable water production field. CR. 676R.

Engineering Mechanics (EM)

In addition to the courses listed below, the faculty of the Department of Civil Engineering and Engineering Mechanics 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 engineering, environmental engineering, soils engineering, transportation engineering, surveying and mapping, and urban planning and engineering.

Credits for these courses are offered in both civil engineering and engineering mechanics.

502. Introduction to Finite Element Methods (3) II (Identical with C.E. 502)

May be conveved with 400-level course.

505. Continuum Mechanics (4) I 1989-90 Analysis of deformation, principal stresses and strains, velocity fields, and rate of deformation; constitutive and field equations; elementary elsticity.

506. Fracture Mechanics (3) II 1990-91 Modes of fracture; crack propagation; Griffith energy balance; crack tip plasticity; J-integral; fatigue cracks; analytical and numerical techniques; constitutive models for damaged materials. P. 506 or consent of instructor.

511. Advanced Finite Element Analysis (3) II Approximation functions, Lagrangian and Hermitian interpolation, isoparametric elements and null spaces in FEM, mixed and boundary element methods, nonlinear analysis, nonlinear problems in solids under static and dynamical loads, time integration schemes, fluid and heat flow coupled problems and mass transport. P. 402 or consent of department before enrolling. (Identical with A.M.E. 511)

530. Advanced Structural Mechanics (3) II (Identical with A.M.E. 530)

956. Seminar

b. Geomechanics/Mechanics (1) [Rpt.2] II (Identical with C.E. 596)

603. Elasticity Theory and Application (3) I General three-dimensional equations of elsticity; 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.

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 surface.


635. Matrix Methods in Structural Mechanics (3) I Formulation of the force and displacement methods; the finite element method, with application to bar, beam, plate, and shell structures; organization and development of computer programs; linear and nonlinear systems. P. C.E. 331 or A.M.E. 433.

637. Plates and Shells (3) I Theory and analysis of circular, rectangular and continuous plates by classical, numerical and approximate methods; introduction to in-plane forces and shells. P. C.E. 336 or A.M.E. 434.


Classics (CLAS/GRK/LAT)

Modern Languages Building, Room 371 (602) 621-1689

Professors Norman Austin, Albert Leonard, Jr., Garret Percy (Emeritus), David Soren An Associate Professor is Jon D. Solomons. Acting Head, Richard C. Jensen, Thomas D. Worthen.

Assistant Professors Holt Parker, Mary Voyatzis

The department offers a degree of Master of Arts with a major in classics with concentrations in philosophy (Greek/Latin) or critical Greek. The graduate courses are open to all graduate students with the permission of the instructor, with the exception of 500, 553, and 599, which are open only to students admitted to the Master of Arts degree program in classics.

Greek (GRK)

502. Greek Reading Course (3) [Rpt.] Readings in major Greek authors including Homer, Plato, and the historians and dramatists. P. 3 units of 400-level Greek.

509. Greek Composition (3) Analysis of Greek prose style and practice in composing Greek prose. P. 3 units of 400-level Greek.

510. Classical Philology (3) (Identical with Clas. 510)

512. Readings in Greek Philosophy (3) Extensive readings in Greek in one of the following areas of Greek philosophy: the pre-Socratics, Hellenistic ethics and epistemology, Aristotle's Nicomachean Ethics. P. 3 units of 400-level Greek. (Identical with Phil. 512)

521. Greek Lyric Poetry (3) Study in Greek of the early Greek Lyric writers from Archilochus to Bacchylides, including Pindar. P. 3 units of 400-level Greek.

524. Homer (3) Close reading of selections from the Iliad and Odyssey in Greek and an introduction to the critical secondary literature. P. 3 units of 400-level Greek.

528. Roman Historians (3) [Rpt.] Readings in Latin from the Roman historians and biographers. Selections from Livy, Caesar, Tacitus, and Suetonius. May be repeated without duplicating readings. P. 3 units of 400-level Latin.

529. Silver Age Latin (3) [Rpt.] Reading in Latin writers of the early Empire. Selections will be drawn from Petronius, Marullus Lucretius, and Apuleius. P. 3 units of 400-level Latin.

596. Seminar

a. Latin Literature (3) Open to majors only.

597. Greek Literature (3) Open to majors only.

Latin (LAT)

501. Latin Reading Course (3) Readings in one of the following: epic, lyric, drama, historiography, satire, epistles, novel, philanthropy or technical or medieval literature. P. 3 units of 400-level Latin.


510. Classical Philology (3) (Identical with Clas. 510)

513. Augustan Literature (3) Survey of the major writers of the Augustan Age, the period from about 30 B.C. to 14 A.D., with the excepion of the Elegiac poets. Readings in Latin. P. 3 units of 400-level Latin.


515. Latin Love Elegy (3) Reading in the Latin texts of Ovid, Tibullus and Propertius. P. 3 units of 400-level Latin.

518. Roman Satire (3) [Rpt.] The Roman satirists, with special attention to the satires of Horace and Juvenal. Readings in Latin. P. 3 units of 400-level Latin.


523. Roman Drama (3) Representative plays of Plautus, Terence and Seneca, read in Latin. P. 3 units of 400-level Latin.


526. Roman Historians (3) [Rpt.] Readings in Latin from the Roman historians and biographers. Selections from Livy, Caesar, Tacitus, and Suetonius. May be repeated without duplicating readings. P. 3 units of 400-level Latin.

528. Silver Age Latin (3) [Rpt.] Reading in Latin writers of the early Empire. Selections will be drawn from Petronius, Marullus Lucretius, and Apuleius. P. 3 units of 400-level Latin.

596. Seminar

a. Latin Literature (3) Open to majors only.

597. Greek Literature (3) Open to majors only.
Communication

543a: Paleolithic through the end of the Middle Bronze Age.
53b: The Minoan and Mycenaean civilizations. 543a is not prerequisite to 53b. P, 6 units in classics, history, or anthropology. (Identical with Anth. 543a-543b).

3. Introduction to Graduate Study in Classical Archaeology (3) An historical and critical survey of classical archaeology with discussion of recent developments in the field. P, 340a or 340b.


5. Greek and Roman Painting (3) Greek painting from the Dipylon vases of the somatic period in Athens to the Orientalizing imitative style of Corinth and the black and red figured Attic style. Also, survey of ancient manuscript and mosaic art. P, 340a-340b.


7. Greek and Roman Provincial Archi-}


9. Greek Pottery 1200-400 B.C. (3) The development of Greek pottery from the collapse of the Mycenaean empire to the close of the archaic period. Special attention to shapes, decoration, function, and artistic and technical styles.

10. Classical Field Archaeology (3) [Rpt./1] Old training and lecture program for students majoring in classical archaeology; includes trench supervision, stratigraphy, locus theory, and oral and written reports on field techniques. Offered at several archaeological sites in the Mediterranean area.

11. Topics in Greek and Roman Archaeology (3) Research papers and oral presentations on different aspects of Greek and Roman archaeology; preparation in writing scholarly articles for refereed journals. P, 340a or 340b.

12. Topics in Greek and Roman Archaeology (3) Research papers on an aspect of ancient architecture which involves the study of monuments themselves but attempts to consider a building in its physical and cultural setting.

13. Roman Art and Architecture (3) The fifteenth and sixteenth centuries Italian art and architecture from Etruscan beginnings through the emigration to the late Empire. P, Art 117, 119, or 5 units in ancient history. (Identical with Art 584).

69. Seminar

69a. Aegean, Roman and Mediterranean Provincial Archaeology (3) Open to graduate majors only.

Clinical Engineering (see Engineering)

Fashioning, Textiles, and Interior Design (see Family and Consumer Resources)

Communication (COMM)

1. Nonverbal Communication (3) I II Theory and research on social communication codes (kinesics, touch, voice, appearance, use of space, time and artifacts) and social functional considerations of communication and management, relational communication, emotional expressions, regulation of interaction, social influence.

517. Relational Communication (3) I II The relational communication process and messages people use to define interpersonal relationships, including dominance-submissiveness, affection, involvement and similarity.

520. Communication and the Legal Process (3) I Present a number of accomplishments and challenges in the social scientific study of law, with special emphasis on the effects of communication and social structure on the legal process. (Identical with Soc. 520).

521. Political Communication (3) I Investigation and analysis of communication principles and practices in contemporary and effective office.

522. Communication Research Methods (3) I II Theories of communication and their research backgrounds; research methodology in communication.


562. Communication and Human Relationships (3) S An advanced course enabling students to design and conduct research in communication skills in the interpersonal, group, and organizational dimensions of their lives.

589. Scholarly Communication (3) II (Identical with LIS 589).

596. Seminar

596a. Political Behavior (3) [Rpt./2] I II (Identical with Pol. 596b. which is home).

610. Communication Theory I (3) I An overview of theoretical perspectives on the role of verbal and nonverbal communication in the process of generating and understanding meaning, and the study of interpersonal processes.

620. Communication Theory II (3) II An overview of theoretical and historical perspectives on communication strategies used in social influence attempts from interpersonal to mass media contexts.

621. Theory Construction in Communication (3) I Theoretical and meta-theoretical positions in the discipline of communication with an emphasis on approaches to analyzing and developing original theories.

680. Research Methodologies I (3) I An introduction to research methods and designs used in contemporary communication research.

670. Research Methodologies II (3) II Advanced study of research design and statistical analysis contemporary communication research.

671. Research Methodologies III (3) II I Issues in measurement and sampling in laboratory and field research in communication. P, 650.

696. Seminar

696a. Nonverbal Communication (3) [Rpt./3] II I Literature as Communication (3) [Rpt./3] II I Rhetorical Theory and Criticism (3) [Rpt./3] II I Social Influence (3) [Rpt./3] II I Mass Media (3) [Rpt./3] II I
f. Linguistic Investigations and Applications (3) [Rpt.] I II (Identical with Ling. 696f)
g. Message Analysis (3) [Rpt.] I
h. Organizational Communication (3) [Rpt.] I
i. Interpersonal Communication (3) [Rpt.] I II
j. Information Processing and Management (3) [Rpt.] II
k. Research Methods (3) [Rpt.] I II

Comparative Literature and Literary Theory (CPLT)
Modern Languages Building, Room 445 (602) 621-1780

Committee on Comparative Literature and Literary Theory (Graduate)

Professors J. Douglas Canfield, Director (English), Norman A. (English), Barbara A. Babb (English), Jonathan Beck (French and Italian), David H. Chisholm (German), William Epstein (English), Lawrence J. Evers (English), Adel Gamal (Oriental Studies), John Garrard (Russian and Slavic Languages, Literature, and Linguistics), N. Scott Momaday (English), Suresh Raval (English), Eliana S. Rivero (Spanish and Portuguese), Herbert N. Schlichting, Jr. (English), Charles Tatum (Spanish and Portuguese)
Associate Professors Susan H. Aiken (English), Adele Barker (Russian and Slavic Languages), Esther Fuchs (Oriental Studies), Jerold E. Hogle (English), Ingeborg Kohn (French and Italian), Ronald C. Miao (Oriental Studies), Judith L. Miller (Spanish and Portuguese), Robert E. McKee (French and Italian), O'Donnell (English), Charles Sherry (English), Jon Solomon (Classics), Thomas Spaulding Willard (English), Linda Zwinger (English)
The Committee on Comparative Literature and Literary Theory offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in comparative literature and literary theory. The cooperating departments include Classics, English, French and Italian, German, Oriental Studies, Russian and Slavic Languages, and Spanish and Portuguese.

The Department of Computer Science offers programs leading to the Master of Science and Doctor of Philosophy degrees in computer science. Students may choose their literatures from these departments or any other area in which the University affords expertise, such as American Indian Studies. The master's degree is considered primarily as leading to the Ph.D. degree.

Admission to the program is based on the following kinds of evidence: (1) Excellent undergraduate performance in language and literature (preferably majors and minors) as indicated by a transcript. (2) Three letters of recommendation from persons familiar with the student's performance in language and literature. (3) An example of the student's writing on a literary topic. For students applying for the doctoral program this must be an article-length and article-quality piece that will serve as a qualifying exam.

In addition, students wishing to study in English, French, German, Spanish, and Russian should submit the following kinds of evidence of competence (scores in verbal aptitude and area competence are expected to be above the 75th percentile): (a) GRE Aptitude test, with emphasis on verbal competence. (b) GRE Subject test in one literature (not available in Russian). (c) GRE Subject test in another literature, or (d) GSFLT exam in a second language. (e) TOEFL exam for foreign students. Applicants' linguistic competence to do graduate-level work in the literatures of the particular languages will be judged by a special committee.

Master of Arts: Degree requirements include at least 36 units: 24 units in graduate-level literature courses in at least two original languages; no more than 12 units may be taken in the student's native language; 6 units 503a-503b; 3 units in a basic linguistics course (such as Ling. 500); 3 units 550. A final examination evaluated by the Executive Committee, augmented by at least one specialist in the area of the paper.

Doctor of Philosophy: Doctoral candidates are required to take at least 48 units for the major. 18 units dissertation; and a minor. Course work (at least 6 units of which must be in 696) aimed at a preliminary exam in (a) a genre of a period (or some other justifiable combination) in at least two literatures; (b) a branch of literary theory; (c) either (1) a third literature, same genre, same period, or (2) an ancillary discipline (such as anthropology, linguistics, history, American, African, American Studies, women's studies) or an interdisciplinary combination. If a discipline is chosen and one of the student's literatures is listed as a related discipline, then the student must pass a reading exam in a second foreign language.

Minor: Supporting areas of study will be approved by the Doctoral Director and Executive Committee and may be obtained through any academic unit offering an approved doctoral minor.

503a-503b. Introduction to Comparative Literature and Literary Theory (3-3) Major theories of representation in the West. 503b: Non-Western theories of literature (Amerind, Chinese, Japanese, Indian, and Arabic). (503a is identical with Eng. 503a; 503b is identical with Or.S.: 503b)

550. Modern Theories of Criticism (3) Twentieth-century theories of criticism most applicable to the study of literature, such as semiotics, structuralism, post-structuralism.

561. Linguistics and the Study of Literature (3) II 1990-91 (Identical with Ling. 561)

696. Seminar a. Comparative Literature and Literary Theory (3) [Rpt.] I II

Composition (See Music)

Computer Engineering (See Electrical and Computer Engineering)

Computer Science (CSC)
Gould-Simpson Building, Room 721 (602) 621-6613

Professors Gregory R. Andrews, Acting Head, Ralph E. Griswold
Associate Professors Peter J. Downey, Udi Manber, Eugene W. Myers, Jr., Richard D. Schlichting
Assistant Professors Saumya K. Debray, Scott E. Hudson, Norman C. Hutchinson, Sanjay Mathur, John C. Peterson, Larry L. Peterson

The Department of Computer Science offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in computer science. The Department's programs are designed for graduate students for professional positions in the design and development of computer systems and applications, and for scientific staff positions in industrial or academic computing research. Areas of research interest within the department currently include programming languages, operating systems, distributed processing, analysis of algorithms, software engineering, computer networks, computer graphics.

Applications for admission should hold a undergraduate degree in computer science or related field. In addition to the application, materials submitted to the Graduate CoC applicants must submit to the department the results of the General Test of the Graduate Record Examination as well as from the Computer Science Subject Test. The department requires that two letters of recommendation be submitted.

A brochure describing admissions requirements and degree programs in detail is available from the department.

Master of Science: 30 units of graduate credit are required, including core courses 505, 553, 573, and at least one Advanced Topic. A thesis is not required, but with department approval a student may elect to submit one. Doctor of Philosophy: Doctoral students must complete 42 units of graduate credit in the major including the M.S. core, 520, 545, and 576, and at least two Advanced Topics. Course work is approved by the department.

No foreign language requirement.

Doctoral candidates majoring in other disciplines may minor in computer science by completing a sequence of courses and examinations set by the department.

502. Mathematical Logic (3) I 1989-90 (Identical with Math. 502)

510. Software Design and Implementation (3) I The specification, design, implementation, and documentation of complex software systems. Includes a large programming project.

520. Principles of Programming Language (3) Global semantics of algorithmic languages, including scope of declarations, data types, retention, block structure, binding time, subroutines, coroutines, extensibility, implement-ation issues. P. 527, 430.

521a-521b. Advanced Systems Models and Simulation (3-3) (Identical with M.S. 521a-521b)

520. Principles of Concurrent Programming (3) I Fundamental concepts of concurrent programming; synchronization mechanisms based on a consistent view of shared memory. P. 452, 500.

520. Software Tools (3) I II The design and implementation of programs that assist in programming development, such as file utilities, editor and text processors. Includes a substantial pc programming project. P. 237 or E.C.E. 271b.


541. Software Engineering (3) I System analysis, software requirements, project management, configuration control, documentation, software quality assurance. P. 437, 452.

545. Analysis of Algorithms (3) I Time, space complexity; recurrences; algorithm design techniques; lower bounds; graph, matrix, a
Advanced Topics in Algorithm Analysis

15.

* String and List Processing (3) I Data
   recognition, pattern matching, programming
   niques; applications. P. 430, 473

* Advanced Operating Systems (3) I
   system design, implementation and
   memory management; protection mechanisms; operating sys-
   ter for parallel and distributed systems. P. 510

Translators and Systems Software (3) II
   concepts of compilation of block-
   culated languages. Topics include lexical
   analysis, top-down and bottom-up parsing, anti-
   nesis, syntax-directed code gener-
   i, debugging. P. 473, 510.

Principles of Compilation (3) I Detailed
   of more advanced aspects of compila-
   topics include compiler writing systems,
   ving programs, analysis and optimiza-
   register allocation, code generation. P.

Database Systems (3) I Theoretical and
   cal aspects of database: data models,
   base languages, deductive databases,
   design, dependency theory, query
   concurrence control and recovery.
   30 and 473.

Artificial Intelligence (3) I Theory and
   of artificial intelligence: problem repre-
   tion, searching techniques, heuristics,
   playing, predicate calculus, reasoning,
   dge representation, expert systems. P.

1a-571b. Digital Systems Design (3-3)
   with E.C.E. 571a-571b)

2. * Continuous-System Simulation (3) I
   with E.C.E. 572)

3. * Theory of Computation (3) II Mathe-
   matical preliminaries; finite automata, regular
   rs, pushdown automata, Turing machines,
   decidability. P. 227, Math. 243. (Identical with

4. * Digital Logic Design (3) I II (Identical
   h E.C.E. 574)

5a-575b. Numerical Analysis (3-3)
   Identical with Math. 575a-575b)

5. * Computer Architecture (3) I An over-
   w of computer systems from basic com-
   to complete systems. Circuits; CPU,
   mory, and I/O organization; complete sys-
   ms from minicomputers to supercomputers. P.

6. Computational Methods of Algebra (3)
   Identical with Math. 578)

7. * Game Theory and Mathematical Pro-
   (3) II 1989-90 (Identical with Math.

8. * Computational Linguistics (3) I Identifi-
   h Ling. 588)
   y be convened with 400-level course.

10. Advanced Topics in Programming Lan-
   ages (1-3) I Design, implement-
   , and compilation of programming
   ngues; specific topics to be determined by
   ment, current language and faculty and student terest.

10. Advanced Topics in Software Systems
   (3) I Problems in design and develop-
   of large systems of programs;
   cific topics to be determined by current
   and faculty and student terest.

15. Advanced Topics in Algorithm Analysis
   (3) I Design and analysis of
   gories; specific topics to be determined by
   ment, current language and faculty and student terest.

12. Advanced Topics in Operating Systems
   (-3) I Operating system design,
   ving, analysis, and performance; spe-
   fic topics to be determined by current litera-
   ure and faculty and student interest.

673. Microprocessors, Minicomputers and
   Real-Time Distributed Processing (3) II
   with E.C.E. 673)

764. Sequential Circuits and Automata (3) I
   with E.C.E. 674)

966. Seminar
   a. Foundations of Computing (3) [Rpt./2] II
   P, Ph.D. candidate or consult depart-
   ent before enrolling.

Conducting
   (See Music)

Consumer Studies
   (See Family and Consumer Resources)

Correctional Administration
   (See Management and Policy)

Counseling and Guidance
   (See Family and Consumer Resources)

Creative Writing
   (See English)

Criminal Justice Administration
   (See Management and Policy)

Dairy Science
   (See Animal Sciences)

Dance (DNC)
   Gittings Building, Room 14
   (602) 621-4688

Committee on Dance
Professor John M. Wilson, Chairperson
Associate Professors Isa Bergsohn, Nina Janik

The Committee on Dance offers a dance con-
ent within a drama major, Master of Arts
degree, in cooperation with the Drama Depart-
ent. Interested students should consult the Committee on Dance.

539a-539b. * Advanced Pointe Technique (1-1)
   Barre work; continuing development of
   speed, and stamina; introduction of advanced barre combinations.
   Center work; allegro en pointe, also adagio,
   and piuettes and consecutive turns. 539b:
   Continuation of 539a with increasing difficulty and complexity in the enchainments. 2S. P.
   audition.

   Hancock

541a-541b. * Modern Dance Technique III
   (4-3) P. 341b. Nielsen

543. Dance Ensemble (2) [Rpt./1] I Rehears-
   al methods, repertory development, and perform-
   of dance with particular emphasis on ensemble. 4S. P. repertory audition; intermedi-
   level in modern and ballet (340a-340b, 341a-341b).

545. * Advanced Chorography (2) I Move-
   ment, motiff development for solo and group com-
   sition. P. 245b. Nicholson

546. Dance Program Administration (3) II
   1990-91 historical and current factors affecting
career development in dance and dance-
related fields; practical organization of pro-
grams. (Identical with Dram. 546)

550. Literary Resources for Choreography
   (3) II 1989-90 Studies in primary world literature, in
drama, and in psychology of personalities as sources for choreographic themes; presenta-
tion of motifs and scenario. 6S. P. 445. (Identical with Dram. 550)

551a-551b. * Ballet Repertoire (2-2) [Rpt./12
   Repertoire from romantic, classical and cons-
   truction by Bourov-

595. Colloquium
   a. Evaluation of Dance and Body Technique
   P. 2P intermediate level ballet or modern
dance techniques. (Identical with Dram. 595a)

697. Workshop
   a. Concert Production and Choreography
   (1-4) [Rpt./4 units] II 4 to 8 S. P. 445

697. Workshop

Dietetics
   (See Nutrition and Food Science)

Drama (DRAM)

University Theatre Building, Room 104
   (602) 621-7008

Professors Robert C. Burroughs (Emeritus), J.
   Michael Gillette, Robert A. Keyworth (Emer-
   itus), Frank K. La Ban, Peter R. Marroney
   (Emeritus), Sam Smiley

Associate Professors Patricia D. Van Metre, Act-
   Head, Harold W. Dixon, Rosemary Gip-
   rich, Richard T. Hanson, Peggy Kelner,
   William A. Lang, Peter Lehman, Mary Z.
   Maher, Jeffrey L. Warburton, Diane J.

The Department of Drama is committed to pro-
iding professional training at the under-
graduate and graduate levels in the theatre arts
through a program of performance-centered ac-
ivities and creative studies, the object of
which is to insure that each student acquires a
thorough understanding and appreciation of
the theatre and cinema arts through classroom
work, studio/laboratory training, and University
Theatre productions. The program is designed
to instill in the student the highest academic
standards and professional skills required to ini-
ate a career in educational and/or professional theatre.

The Department of Drama 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 professional training pro-
gram emphasizing artistic achievement. Admis-
sion is competitive and based on an evalua-
tion of the applicant’s professional potential, train-
ability, and talent. The program encompasses a
rigorous regime of studio training, classroom
study, and University Theatre production.

In cooperation with the Department of
Drama, the Committee on Dance offers a pro-
gram leading to the Master of Arts in drama with a dance
diploma. For a listing of graduate courses, see Dance.

501. Advanced Stagecraft I (3) I Advanced
   sthetics in scenic construction methods and
   techniques. P. 111

504. Musical Theatre III (3) II Intensive
   rs in music and dance, exploration of the major historical
   genres and styles of the American musical thea-
   re. 2R, 2S. Open to majors only. P. 304 and
   audition.

514. Advanced Make-up (2) [Rpt./2] History
   nd practical application of theatrical make-up.
Design and construct such items as masks, prostheses, and wigs. P. 155.

515. Theatre Graphics II: Drafting (3) I Advanced theatrical perspective, scenographic and graphic techniques. P. 120.


520. Advanced Acting and Directing I (3) II Special problems, practice and trends in designed light for theatrical productions. P. 220.

521. Special Effects for Theatre (3) II 1990-91 (Identical with Dnc. 522) Advanced techniques in special effects of thean. 2R, 3L.

523. Scene Painting (3) I Techniques and methods of scenic painting. P. 223.

524. Advanced Scenic Design I (3) I Advanced techniques and methods of scenic design. P. 223.

525. Advanced Stagecraft II (3) I 1989-90 Advanced techniques in construction and problem solving in technical theatre production; microcomputers, hydraulics, rigging, welding, plastics and study of scenic problems. P. 40.

527. Advanced Stage Costume Construction I (3) II Advanced techniques in costume construction, including period pattern designing and cutting, draping techniques. P. 116.


530. Stage Management (2) I Principles and techniques of stage management, practical applications, problems and analysis of stage management. P. 11, 195.

531. Theatre Publicity and Box Office (2) I Publicity, press releases, sales, advertising, display techniques, subscription procedures. P. 12 units of drama.

532. Theatre Management (2) II Amateur, educational and professional theatre organization and management; theatrical contracts, professional unions and representative organizations. P. 12 units of drama.


541. Scenography (3) I The integration of scenery, costume, light and sound into a total production design.

542. Advanced Stage Lighting (3) I 1990-91 An advanced study of lighting design for opera and dance; discussion of theoretical (light plots) and practical (light lab) projects. P. 420.

543. Advanced Stage Lighting III (3) I 1989-90 An advanced study of lighting design for musical theatre; theoretical (light plots) and practical (light lab) projects. P. 420.


546. Dance Program Administration (3) II 1990-91 (Identical with Dnc. 546)

547. Advanced Stage Costume Construction II (3) II 1989-90 Advanced techniques in draping, period styles, tailoring, dyeing, painting fabrics and a study of a variety of fabrics and their uses. P. 427.

548. Acting and Stage Costume Design II (3) I 1989-90 Advanced costume design; emphasis on research, line and color analysis, and realized projects. P. 429.

549. Acting V (3) II Intensive study of classical actorly styles with emphasis on Shakespeare.

550. Literary Resources for Choreography (3) I 1991-90 (Identical with Dnc. 550)


552. Acting VII (3) [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, audition.

553. Acting VIII (3) II Intensive scene study and character analysis. Survey and review of major modern acting theories and techniques. 2R, 2S. P. 452, audition.

555. Directing I (3) I Basic techniques of stage directing including play analysis, director-actor communication and technical problems of movement, composition, picturization and blocking. 2R, 2S.

556. Directing II (3) II Techniques of stage direction with the study of factors leading to a competent ability to do close transcriptions given to director-designer communication and the production process. Direction of one-act plays. 2R, 2S, P. 455, audition.

560a-560b. Writing for Stage and Screen (3-3) Preparation and analysis of short scripts for stage and motion pictures.

561. Acting and Performance (2) [Rpt./2]. II 1990-91 The development and communication of a visual idea for performance art; exploring all mediums of visual and aural communication.

568. Dialects in Performance (3) Application of suitable phonetic theory toward a systems approach to acquiring dialects for performance in stage, television and radio productions. 1R, 4S. P, ability to do close transcription in International Phonetic Alphabet (IPA).

574a-574b. Film Theory and Criticism (3-3) I Advanced studies in current cinematic theory and criticism. Historical examination of major film theories including formalism, realism, classical Hollywood, structuralist, semiotic and feminist theories.

575. Screen Acting Techniques (3) II Principles and techniques of various performance methods involved in acting for television and motion pictures; problems faced by the professional actor seeking employment in these media; on camera experience with directed exercises and dramatic scenes. 2R, 3L, P. 151, audition.

595. Colloquium a. Evaluation of Dance and Body Techniques (2) I (Identical with Dnc. 595a)

597. Workshop a. Technical Direction (1-6) [Rpt./20 units] II S b. Costume Design (1-6) [Rpt./20 units] II S c. Light/Sound Design (1-6) [Rpt./20 units] II S d. Property Design (1-6) [Rpt./20 units] II S e. Scene Design (1-6) [Rpt./20 units] II S f. Performance (1-6) [Rpt./20 units] II S

Students may earn a maximum of 9 units in Dram. 696 with a maximum of 6 units in any one area.

600. Introduction to Graduate Study of Dramatic Arts (3) 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 (3) [Rpt./1] I Advanced study and exercise in voice and movement for the actor: standard stage speech, delivery, period problems, vocal and movement. 6S, P, audition.

640. Dramatic Criticism: Tragedy (3) I Core parative analysis of tragedy and theories: tragedy from antiquity to the present for stage and screen; writing of critical papers.

641. Dramatic Criticism: Comedy (3) I Core parative analysis of comedy and comic theatre from antiquity to the present for stage and screen; writing of critical papers.

642a-642b. Studies in Theatre History I (3) Concentrated study in theatre history, with major emphasis on the physical theatre, standard scholarly works, and source materials. 642a: Beginnings to circa 1660. 642b: Circa 1660 to 1975. 642a is not prerequisite to 642b.

644. History of the American Theatre (3) I Studies in the American theatre and drama. Directed and individual projects will be assigned.

650. Experimental Theatre I (3) I Stanislavsky experimental theatre techniques and theories of the first half of the twentieth century. Rehearsal and performance of selected projects.

655. Advanced Directing I (3) I Techniques of stage directing, including play analysis, director-actor communication, director-designer communication, blocking, movement composition; use of directorial style and adaptation of directorial philosophies. 2R, 2S.

656. Advanced Directing II (3) I Techniques of analyzing and staging classical texts for contemporary audience; use of directorial style and the adaptation of directorial philosophies with an emphasis on staging the plays of Shakespeare. 2R, 2S, P. 449, 555.

656a. Seminar a. Contemporary Trends (1-3) [Rpt./6 units] I P b. Special Topics in Acting (1-3) [Rpt./6 units] I P c. Special Topics in Directing (1-3) [Rpt./6 units] I P d. Musical Theatre Production (1-3) [Rpt./6 units] I P e. Special Topics in Playwriting (3) [Rpt./6 units] P f. Film Editing (1-3) [Rpt./6 units] I P g. Documentary and Educational Films (3) [Rpt./6 units] I P h. Special Topics in Stage Costume Construction (1-3) [Rpt./6 units] I 1989-90 I I I i. Period Design Style (1-3) [Rpt./6 units] I P j. Special Topics in Scene Design (2) [Rpt./6 units] I 1989-90 P. 424, 555 I P k. Special Topics in Costume Design (2) [Rpt./6 units] I P 292 m. Special Topics in Technical Production (3) [Rpt./6 units] I 1990-91 P. 425. 555 n. Special Topics in Lighting Design (2) [Rpt./6 units] I P. 420.

Ecology and Evolutionary Biology (ECL)

Biological Sciences West Building, Room 310
(602) 621-1588

Professors Conrad A. Istok, Head, William A. Calder, III, E. Lendell Cockrum (Emeritus)
department offers programs leading to the
step of Science and the Doctor of Philosophy
thesis with majors in ecology and evolution
biology and in botany. Concentrations are
available in plant ecology, systematics and evo-
cution; evolutionary theory; ecological and
evolutionary genetics; environmental biology;
animal behavior; population/community ecol-
ogy; vertebrate biology/systematics; evolutionary morphology; and ornithology. The
department maintains excellent collections of
birds, amphibians, reptiles, fishes, and mam-
mals. Advanced herbarium is shared with the
Department of Botany.
Field work is facilitated at the Marine Biology Station at Puerto Peñasco, Sonora, Mexico and by the availability of the
Sonoran Desert and the Chihuahua Mountains.
Southwestern Research Station, Portal, Sonora, the Research Ranch, Elgin, Arizona, Isla del Desierto Laboratory on Tumamoc Hill,
and others.
Applicants are required to furnish the depart-
ment with completed departmental application
forms, copies of scores on the Aptitude and
Analytic viewing tests of the Graduate School
Examination, copies of transcripts of all
weighted courses, copies of GRE scores (in addition
those required by the Graduate College),
d three letters of recommendation from per-
sons qualified to evaluate the applicant's schol-
astical potential. Applications should be submitted
January 15; admission is normally approved
for the semester beginning their graduate study
with the fall semester. Applicants are encour-
eged to seek external financial support such as the National Science
University; other financial aid may be obtained.
Of the department will make every effort to offer finan-
cial aid in the form of teaching or research assist-
ships.
Courses
The following courses are offered.

503R. Biology of Animal Parasites (3) (Identical with VSC 503R)
503L. Parasitology Laboratory (1) (Identical with VSC 503L)
505. Aquatic Entomology (3) II 1990-91 (Identical with WFC 505)
512. Insect Behavior (3) II 1989-90 (Identical with Ento. 512)
514. Plants of the Desert (2) S Designed for prospective bio. teachers and others wishing to become familiar
with common native and cultivated plants; identi-
fication, ecology, and uses. 518a: Illustration-Photography 2 (Identical with 518b) Individual basic training in the evolution of these tech-
niques and graphic art techniques. 518a: Illustration-Photography. Consult department before enrolling. (Identical with Anth. 518a-518b)
519. Molecular Evolution and Genome Organization (3) II 1990-91 A rigorous and
comprehensive survey of both the molecular
and evolutionary details of genome organiza-
P, 320, year of calculus.
521. Philosophy of the Biological Sciences (3) 1989-90 (Identical with MCB 521)
529. Cytogenetics (3) II Investigation into the structure and function of chromosomes and
their role in heredity and evolution. 2R, 3L, P, 302 (Identical with 523)
524. Theoretical Population Genetics (3) 1 Mathematical theory of modern population
genetics developed from first principles, with
emphasis on evolutionary implications and the
developmental and historical approaches to ideas. 2R, 3L, Math. 232
(Identical with Anth. 524 and Gene. 524)
525. Speciation (2) (Rpt. I) Mechanisms of evolution in the formation of races and species
of animals and plants. P, 320. (Identical with Gene. 525)
528R. Advanced Microbial Genetics (3) II (Identical with MCB 528R)
528L. Advanced Microbial Genetics Laboratory (2) I (Identical with MCB 528L)
531. Environmental Physiology (3) II 1989-90 Analysis and synthesis of recent studies of the physiological responses of animals to
eir environments. P, 468R
532. Physiological Ecology (2) II 1989-90 Analysis and synthesis of contemporary
research on organismic-function and its inter-
face with ecology, replacing "black box"
assumptions with understanding of capacities and constraints. P, 506R
534. Population Interactions (4) (Rpt. I) Empirical and theoretical treatment of competi-
tion, exploitation, and mutualism within and between species and application of these methods to ecological problems. Computer
lab. 3R, 3L, P, 302, two semesters of calculus.
535. Evolution (3) I A balanced survey of the present-day concepts of the process and prod-
ucts of evolution, with emphasis on contrasting
models and their consequences; recent tech-
niques for the elucidation of phylogenetic path-
nways. P, 302, 320; Math. 125a, P or CR, 125b.
(Identical with Gene. 535)
536. Plant Physiology (3) Plant systems and processes giving rise to ecological patterns in plant pop-
ulations and communities. 2R, 6L Field trips. P, somebotany and general ecology.
538. Biogeography (3) II The role of historical
and ecological processes in determin-
ing the past and present geographic distribu-
tion of species and plants. P, 182 or Geos. 225.
(Identical with Anth. 538)
540R. Oceanography (2) I 1990-91 Introduction to the physical, chemical, geological, and biological dimensions of the oceans, with
emphasis on the importance of these aspects.
540L. Oceanography Laboratory (2) I 1990-91 Field and lab. investigations of the Gulf of California, with emphasis on research
techniques important to biological oceanography. Weekend field trips. P or CR, 540R
541. Limnology (4) (Identical with WSCF 541)
542. Marine Ecology (6) S A field introduction to basic concepts in marine ecology with
emphasis on research methods involving the behavior 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 department before enrolling.
543. Advanced Studies in Marine Biology (2) (Rpt.) I Analysis and discussion of current
research in the marine biological sciences.
544. Insect Ecology (3) I (Identical with Ento. 544)
550. Mathematical Population Dynamics (4) II Ecological population dynamics, demogra-
phy and human epidemiology. Emphasis on mathematical models and techniques for data
analysis with particular reference to dynamical systems and chaos. 3R, 3L P, full calculus sequence, upper-level ecology course (302) or
ordinary differential equations (Math. 254 or 256) recommended. (Identical with WSCF 550)
558. Comparative Vertebrate Anatomy (4) I (Identical with VSC 558)
559. Comparative Vertebrate Histology (4) II (Identical with VSC 559)
560. Plant Physiology (4) I (Identical with MCB 560)
(Identical with Tox. 563a-563b)
564a-564b. Lectures in Human Physiology (3-3) Basic principles and concepts of physiol-
ogy applied to humans. P, 304, Chem. 241b, 243b. (Identical with Tox. 564a-564b)
568R. Comparative Physiology (3) II The responses of physiological systems to the envi-
568L. Comparative Physiology Laboratory (1) II Physiological measurement techniques in
laboratory and field studies. P, CR, 568R.
570. Plant Diversity and Evolution (4) I Survey of the diversity and evolution of plant groups,
with emphasis on comparative structure and evolution of major plant divisions. 2R, 6L Field trips. P, 4 units of biology or plant sciences.
571. Ecological Botany (2) (Rpt. I) Evolutionary relationships of orders and families of sper-
matophytes; systems of classification; collection
and identification of local flora. 2R, 6L Field trips. P, 506R
575. Freshwater Algae (4) II 1989-90 Systematics, ecology, and evolution of planktonic and benthic species; field techniques and lab.
culture. 2R, 6L Field trips. P, 4 units of biology or plant sciences.
579. Art of Scientific Discovery (3) (Rpt. I) Techniques of posing questions and solving problems encountered in scientific research, with
emphasis on life sciences and mathematics. P, consult department before enrolling.
580. Invertebrate Zoology (4) I Comparative morphology, physiology, and ecology of inverte-
brates. 2R, 6L Field trips. P, 182.
582. Ichthyology (4) I 1989-90 I Ecology, evolu-
tion and systematics of fishes, with field and
laboratory work on Gulf of California and Arizona fishes. 2R, 6L Field trips. P, 182. (Identical with WSCF 582)
583. Herpetology (4) II Systematics, ecology, and evolution of amphibians and reptiles. 2R, 6L or field work. P, 304.
584. Ornithology (4) II Field trips. Natural his-
tory of birds and its bearing upon the problems of animal behavior, distribution, and evolution.


587. Economics (3) I Concepts and principles of the evolution, development, causation and function of behavior, with emphasis on the adaptiveness of behavior; discussion of selected topics in behavioral biology.


589. Selected Studies of Birds (2) [Rpt.] I Recent advances in ornithology. 1R, 3L or field trip. P, 484. (Identical with W.F.Sc. 589)

590. Quantitative Morphology (3) II 1990-91 Methods for studying form variation and diversification; size-shape relationships; theoretical morphology.


c. Macrowevelopment (2) [Rpt./6 units] I d. Selected Topics in Marine Biology (1-4) [Rpt./6 units] II Field trips. P, junior or senior ecology majors.

e. Sociology (3) [Rpt./3] I f. Plant Population Ecology (1-3) [Rpt./5] I

610a-610b. Research in Ecology and Evolution (1-1) [Rpt.] I II Introduction to the research currently being pursued by faculty and staff in the department. Open to majors only.

620. Population Genetics (3) I (Identical with Gene. 620)

670. Recent Advances in Genetics (2) I (Identical with Gene. 670)

Economics (ECON)

Economics Building, Room 202 (602) 621-6224


Associate Professors Michael K. Block (Management and Policy), David A. Conn, John Z. Drabicki, Donald G. Heckerman, R. Mark Isaac, James C. McBrearty, David E. Pingry, Stanley M. Reynolds, Gerald J. Swanson, Ronald L. Vogel (Management and Policy), Assistant Professors Eskander Ali, Barbara N. Sands

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 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 Business Administration headnotes elsewhere in this catalog.

Applicants must have completed an undergraduate major or minor in economics and must submit scores on the Graduate Record Examination.

Degrees

Master of Arts: All students must complete the core program consisting of 501a, 502a, 520, and 654, 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 the advisor. 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 501a-501b-501c, 502a-502b, 506, 520, 521, 523, and eighteen units of 696-697 economics seminar and workshop courses. A minimum of 66 hours is required.

500. Managerial Economics (3) I & S Microeconomic theory and applications. P, M.I.S. 400 or Math. 123. Advanced degree credit available for nonmajors only. Open only to students admitted to a BPA graduate program.


504. Economic Organization (3) I (Identical with A.Ec. 504)


511. Microeconomic Theory and Behavior (3) I Microeconomic theory with an emphasis on the use of experimental laboratory and field methods for testing the behavioral implications of the theory. P, 520 Math, 123a and 125b.

512. International Agricultural Economic Development (3) II (Identical with A.Ec. 512)

513. Agricultural Price and Marketing Analysis (3) II (Identical with A.Ec. 513)

514. Cost-Benefit Analysis (3) II (Identical with A.Ec. 514)


516. Introduction to Econometrics (3) I Statistical methods in estimating and testing econometric models, and simultaneous equation estimation, identification, forecasting, and problems caused by violating classical regression model assumptions. Advanced degree credit available for nonmajors only. P, 339 or M.I.S. 375 or M.I.S. 552.

520. Theory of Quantitative Methods in Economics (3) I Introduction to the basic concepts of statistics and their application to the analysis of economic data. Designed primarily for entering graduate students majoring in economics. P, CR, 521; consult with department before enrolling.

521. Mathematical Economics (3) I Introduction to the theory and methods of mathematical economics. Designed primarily for entering graduate students majoring in economics. P, CR, 520; consult with department before enrolling.


530. Macroeconomic Aspects of Finance (3) II The effects of changing economic conditions upon a firm's operation, including capital decisions as well as production decisions. P, 534.


558. Business and Economic Forecasting (3) I Forecasting techniques used in business and government: assembly, interpretation and use of economic data; analysis of business conditions; examination of related environment and consequences; construction of actual sales or revenue forecasts.

559. Agricultural Economic Development Latin America (3) II (Identical with A.Ec. 559)

560. Economic Organization and Government Policy (3) I Structure, conduct, and performance of American industry; governance of institutions and policies affecting business. Advanced degree credit available for nonmajors only. P, 300 or 361 or 500; 339 or M.I.S. 552.

561. Economics of Regulated Industries (3) II Economic analysis of the regulated sector of the American economy: including communications, transportation and energy industries, imperfect competition, and efficiency analysis. Advanced degree credit available for nonmajors only. P, 300, 500, 520. M.I.S. 552.

562. Theory and Institutions in Industrial Organization (3) I Major issues in the field of industrial organization. Theoretical, empirical, and historical methods. P, 300 or 361.

568. Environmental Scanning (3) I (Identical with M.A.P. 568 and Mktg. 568)

570. Management and Evaluation of Information Systems (3) I II (Identical with M.I.S. 570)

571. Economics of Water and Land Resources (3) I (Identical with A.Ec. 571)

572. Water Quality (3) I P, 501a, 502a, 521, 549.

573. Computer Methods in Laboratory Economic Analysis (3) I P, Math. 125a, 125b; consult department before enrolling.

574. Economics for Teachers (3) S Co-suit instructor before enrolling.
d. Summer Institute on the American Economy (3) S Consult instructor before enrolling.
e. Economics Education Workshop (2) S Consult instructor before enrolling.
f. Educational Development for Educators (2) S Open to nonmajors only. Consult with department before enrolling.
i. Seminar
   a. Experimental Economics I (3) II
   b. Experimental Economics II (3) I
   c. Economic Analysis of Organizations I (3) II
   d. Economic Analysis of Organizations II (3) I
   e. Econometric Modeling I (3) II
   f. Econometric Modeling II (3) I
   g. Monetary Economics (3) I
   h. Labor Economics I (3) II
   i. Labor Economics II (3) I
   j. Public Policy Analysis I (3) II
   k. Public Policy Analysis II (3) I
   l. International Economics I (3) II
   m. International Economics II (3) I
   n. Advanced Macroeconomic Theory I (3) II
   o. Advanced Macroeconomic Theory II (3) I
   p. Industrial Organization and Regulation I (3) II
   q. Industrial Organization and Regulation II (3) I
   r. Advanced Microeconomic Theory I (3) II
   s. Advanced Microeconomic Theory II (3) I
   t. Mathematical Economics (3) I
   u. Game Theory (3) II
   v. Public Choice I (3) (Identical with Pol. 696v)
w. Public Choice II (3) I (Identical with Pol. 696w)
7. Workshop
   a. Experimental Economics (3) I P, 696a, 696b.
   b. Economic Analysis of Organizations (3) I P, 696c, 696d.
   c. Econometric Modeling (3) I P, 696e, 696f.
   d. Labor Economics (3) I P, 696g, 696h.
   e. Public Policy Analysis (3) I P, 696j, 696k.
   f. International Economics (3) I P, 696l, 696m.
   g. Advanced Macroeconomic Theory (3) I P, 696n, 696o.
   i. Advanced Microeconomic Theory (3) I P, 696r, 696s.

ducation
EDUC/EDA/EDP/HED/ RC/SER/TTE

ducation Building, Room 201
(520) 621-4161

The College of Education offers certain courses that are not directly affiliated with any of the academic divisions in the college. In many cases, these courses are college-wide requirements for various revised degree programs being considered for approval at the time the catalog was being edited. Since implementation of the revised programs is anticipated for the 1989 fall semester, all current and prospective students should check with the Office of Student Services in the college or consult the proper division for information on current degree requirements.

Division of Educational Foundations and Administration
   educational administration . . . . . . . M.A./M.Ed./Ed.S./Ed.D./Ph.D.
   educational psychology . . . . . . . M.A./M.Ed./Ed.S./Ed.D./Ph.D.
   foundations of education . . . . . . . M.A./M.Ed./Ed.D./Ph.D.

higher education . . . . . . . M.A./M.Ed./Ed.D./Ph.D.
Division of Language, Reading and Culture
   bilingual/bicultural education . . . M.A./M.Ed.
   special education . . . . . . . M.A./M.Ed./Ed.S./Ed.D./Ph.D.
Division of Teaching and Teacher Education
   educational media . . . . . . . M.A./M.Ed./Ed.S.
   secondary education . . . . . . . M.A./M.Ed./M.T./Ed.S./Ed.D./Ph.D.

subject areas for secondary school teaching: chemistry, communication, English, family and consumer resources, French, general education, history, journalism, Latin, mathematics, Oriental studies, physics, political science, Russian, Spanish, (and others)
Division of Language, Reading and Culture
   educational media . . . . . . . M.A./M.Ed./Ed.S.
   secondary education . . . . . . . M.A./M.Ed./M.T./Ed.S./Ed.D./Ph.D.

Division of Teaching and Teacher Education
   educational media . . . . . . . M.A./M.Ed./Ed.S.
   secondary education . . . . . . . M.A./M.Ed./M.T./Ed.S./Ed.D./Ph.D.

Education (EDUC)
500. Disciplined Inquiry in Education (3) II S Introduction to research methods in education: analysis of research; writing of research reviews; applying research results in educational settings.
501. Foundations of Education (3) II S Schools and social institutions; political and social influences on education; nature of the education profession; reform and implementation in education.
502. Variations in Learners (3) I S Nature and extent of differences among learners, both among and within groups; causes and factors relating to variations in learners; implications for educational placement, curricular planning and program development.
589. Anthropology and Education (3) I II (Identical with Anth. 589)
600. Quantitative/Inferential Methods in Education (4) I II S Statistical knowledge for use in describing educational research data and relating these between sets of data; statistical relationships among various forms of educational research inquiry. P, 500.
601. Qualitative Methods in Education (3) I II S Introduction to theory and methods of conducting research through extended participant observation in school or community settings; field work, ethnography, case study, qualitative methods. P, 500.
602. Research Design and Techniques in Education (3) I II S In-depth explorations of various research paradigms in educational inquiry and theory; research designs; critical analysis of the structure and logic of various designs and techniques; preparation of research proposals. P, 600, 601.
603. 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.
612. Philosophy of Education (3) III I Analysis of values and conflicts in American culture as these direct educational policy; critical examination of contending philosophies in the light of democratic ideals.
613. History of Western Education (3) III I The historical development of western educational thought from its origins to the present. Development of the revised programs is anticipated for the 1989 fall semester, all current and prospective students should check with the Office of Student Services in the college or consult the proper division for information on current degree requirements.
614. History of Education in the United States (3) III I The development of American educational thought from its colonial origin to the present. Development of the revised programs is anticipated for the 1989 fall semester, all current and prospective students should check with the Office of Student Services in the college or consult the proper division for information on current degree requirements.
615. Educational Sociology (3) III I 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.

Educational Foundations and Administration (EDA/EDP/HED)

Associate Professor Harley D. Christiansen, Sarah M. Dinhm, Joseph D. Gullot (Emeritus), Stanley Pogrow, Donal M. Sacken, Sheila Slaughter.
Assistant Professors Martin Ahuma, Sharon Conley, Marcello Medina, Gary Rhoades.

The division offers programs leading to the Master of Arts and Master of Education degrees with majors in educational administration, educational psychology, foundations of educational and high school psychology. The Doctor of Educational Specialist degree is offered with majors in educational administration and educational psychology. The Doctor of Education degree is offered with majors in educational administration, educational psychology, foundations of education, and higher education. The Doctor of Philosophy degree is offered with majors in educational administration, educational psychology, foundations of education, and higher education.

Concentrations are available within graduate majors offered in the division. Concentrations in educational psychology include school psychology and learning and development. The major in higher education is offered through the Center for the Study of Higher Education, with concentrations in academic administration, student personnel services administration, finance and business affairs administration, and institutional research.

The division also offers certification in educational administration and school psychology. Students seeking institutional recommendation for Arizona administrative certification should major in educational administration. Students seeking certification in school psychology should major in educational psychology. The school psychology training program is accredited by the American Psychological Association and leads to certification as a school psychologist. In the Center for the Study of Higher Education, majors in educational psychology may be designed to meet the requirements for the Arizona Community College Teaching Certificate (Type I) or for entry-level administrative service in institutions of higher education.
An undergraduate grade-point average of at least 2.00 is required for admission to full standing in any graduate program. Applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is generally considered to be a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered.

At the time the catalog was being edited, revisions to many of the division programs were being considered for approval, with implementation expected in the 1989 Fall semester. All current and prospective students should check with the Office of Student Services in the College of Education or the Division of Educational Foundations and Administration for information regarding the status and requirements of all programs and degrees.

**Educational Administration (EDA)**

Education Building, Room 635
(602) 621-3327

660. Administration and the Educational Environment (3) I, II S Introduction to educational administration; overview of administration within school contexts and larger societal environment; organizational and leadership theories.

661. Administration of Bilingual Education Programs (3) I, II 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.


663. Computer Applications in School Administration (3) I Techniques for using computers to make school administration more efficient; using computers to enhance the management of information. P. or CR. 660.

664. Personnel Administration in Education (3) I Composition of school staff and the functions of various personnel; patterns and practices in school personnel management; issues, trends, and prospects in personnel management. CR. 660.

665. Instructional and Clinical Supervision (3) II S Purposes of instructional supervision; organization, roles, and skills for supervisory competency. P. 660.

666. Theory and Behavior in School Organizations (3) I Perspectives on the nature of the individual in the school organization; nature of schools as organizations; development of individual-organizational relationships. P. 660.

667. Educational Governance and Collective Bargaining (3) II Theory and practice of collective bargaining; history of negotiations in the educational sector; impact of statutes and governmental intervention on educational data; and response bias.

668. Management of Curriculum Change (3) II Techniques for administrators to use in analyzing the quality of the curriculum in schools as well as the appropriateness of instructional techniques used to support the curriculum. P. or CR. 660.

671. School Finance (3) I Historical background of the financial problems of education in the United States; economics and principles; sources and distribution of funds for education; budgeting, accounting, and reporting. P. 660, 661 or CR. 660.

672. School Business Management (3) II The general management of school business; administration and accounting of school funds; administration of equipment and supplies; other business operations. P. or CR. 660.

673. Administrative Leadership (3) I Explores the leadership process in education, including the use of both norm-referenced and criterion-referenced test scores in the development of policy issues. P. 660, 661 or CR.

674. Law and Administrative Practice (3) II Legal reasoning and implications of existing social, organizational, and behavioral theories. P. 660, 661 or CR.

675. Theory of Measurement (3) II Advanced statistical methods in educational testing. P. 660, 662 or CR.

676. Classroom Management (3) I, 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. P. 693a, 693b or CR.

682. Educational Program Evaluation (3) I Descriptive, inferential, and correlational techniques for assessing the quality of school programs. P. 541, 558.

685. Child Behavior Disorders and Adjustment (3) I Emphasis on theoretical and methodological issues related to the development of survey and rating scales, sampling procedures, and response bias.

558. Educational Tests and Measurement (3) I Theoretical and practical application of educational measurement techniques; interpretation of test results. P. 541.

559. Testing of Minorities (3) II Current theory and practical issues in the use of norm-referenced tests with individuals from minority cultures.

600. Theories of Human Development (3) II History and analysis of psychological theories of human development and a comprehensive overview of major theoretical systems. P. 500.

601. Psychological Theory in Educative Practice (3) II Major theories of psychology: thought; strategies for utilizing such theories in educational practice. P. 510.

615a-615b. Cognitive Development (3-3) I, II Cognitive theory and research as they are employed in educational and psychological settings. CR. 500 or 501.

619. Design of Instruction (3) II Historical and theoretical bases for designing learning experiences; emphasis on the relevance of learning theory and instructional design. P. 501.

501. Multidimensional Methods in Educational Research (3) II Provides an understanding of and facility with research application in the areas of statistical methods and introduction to multivariate and causal procedures. P. 541.


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501. Multidimensional Methods in Educational Research (3) II Provides an understanding of and facility with research application in the areas of statistical methods and introduction to multivariate and causal procedures. P. 541.

The Community College (3) The scope, activities, and educational functions of the community college, patterns of community college programs.

Higher Education in the United States (1) The scope of higher education in the United States; brief survey of historical developments and philosophic bases, public issues at the state and federal level; uses of institutions and their purposes; characteristics of faculty, students and curricula.

The College Student (3) I History and characteristics of the college student; interests, activities, and social roles. II Development of personality; role of cultural and environmental influences; developmental and normative trends; major current findings.

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.

Student Personnel Services in Higher Education (3) II Student personnel services, roles, procedures, representative programs, current trends.

Curriculum in Higher Education (3) II Study of classical curriculum; development and revision of general education and professional studies; modern curriculum development and innovations.

Teaching in Higher Education (3) II Planning, organizing, and evaluating learning experiences for mature students.

Institutional Research and Planning (3) Development of institutional research programs; short-term and long-term planning; and output measures.

Higher Education Finance (3) I Historical trends in financing public and private higher education; financial resources and types of financial support; alternative methods of financing; and current financial and consumer theories.

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.

Higher Education and the Law (3) II Critical court decisions, past and present, affecting higher education; increasing role of the courts in higher education; increasing role of the courts; legal aspects of resource allocation; personnel policies; and current trends.

Curriculum theory and models; staff development; research findings. Seminar (3) II Procedures for diagnosing and developing reading and writing skills for pupils of below-average achievement level. P, 505, 507, or CR.

Reading, Writing and Texts: A Psycho-Sociolinguistic Perspective (3) I II Readers as users of language; reading and writing as language processes; what makes a text a text.

Language Acquisition and Development (3) I Study of the development of language in young children; focus on oral language and its relationship to emergent literacy; instructional strategies that build on language development.

Applied Linguistics in Education (3) I II The application to curriculum, teaching, and learning of concepts from linguistics, psycholinguistics, and sociolinguistics. P, or CR.

Application of Miscue Analysis (3) I II Study of miscue analysis to explore the reading process, reading research, and readability, as a basis for evaluating readers; applications to reading strategies and curriculum; focus on comprehension, P, or CR.

Language Research Methodology in Education (3) I II Investigation of procedures for conducting literacy research; examples of literacy research paradigms; critical analysis of evidence supporting literacy practices. P, 505, 507, or CR.

Field Experience (3) I II Supervised experience in assessment and instruction of literate-related practices. P, 504, 505, or CR.

Children's Literature in the Classroom (3) I S P, 504, 505. II S (Identical with LING 595b, which is home)

Bi- and Multilingual Children (3) I S P, 504, 505. II S (Identical with LING 595b, which is home)

Multilingual Literacy and Language (3) I Analyses the use of multilingual literature that fosters self-concept, acceptance, and a sense of identity to develop literacy. Includes readings from the major categories of multilingual literature. P, 504, or CR.

Colloquium (3) a. Issues in Language, Reading and Culture (3) I P, 504, 505. II b. Language, Learning, and Reading Disabilities (3) II (Identical with S.E.R. 595b, which is home) c. Issues in Educating Mexican American Students (3) I S P, 504, 505. d. Applications of Language and Literacy (3) [Rpt./9 units] I S

Workshop (3) a. Southern Arizona Writing Project (3-9) [Rpt./12 units] I S (Identical with Engl. 597a) b. Misuse Analysis in Teacher Education (3) II c. Teaching of English (3) I II

Computer Application for Teachers (3) I II Microcomputer operation; computer-assisted instruction; software evaluation; use of author systems and word processors in the classroom; computer mediated instruction; organization for computer use; communications networking; computer networking.

Pre-Reading and Beginning Reading Development (3) I I An examination of various aspects involved in pre-reading and beginning reading development, including psychological, sociological, physiological, linguistic and educational considerations.

Secondary School Reading in the Classroom (3) I II Procedures and procedures for evaluating and developing reading skills needed in content areas.

Classroom Communication and Interaction (3) I II The teacher's role in promoting effective communication and interaction in the classrooms; analysis of both verbal and nonverbal language use.

Classroom Diagnosis and Instruction (3) I II Procedures for diagnosing and developing reading and writing skills for pupils of below-average achievement level. P, 505, 507, or CR.

Research findings. Seminar (3) II Procedures for diagnosing and developing reading and writing skills for pupils of below-average achievement level. P, 505, 507, or CR.

Teaching, Reading, and Writing (3) I Survey of reading and writing relationships: development, instruction, and evaluation.

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Teaching, Reading, and Writing (3) I Survey of reading and writing relationships: development, instruction, and evaluation.
613. Second Language Acquisition in Formal Contexts (3) [Identical with Engl. 613]

627. Development and Supervision in Language Arts (3) I II Organizational patterns of language arts curricula; approaches to improvement of language arts instruction. Delegated to the language arts supervisor and school administrator. P. 527.

634. Reading Comprehension: Theories, Research, and Methods (3) I II Factors affecting cognitive development; methods of influencing growth in reading comprehension; examination and analysis of instructional materials; development of interview techniques. P. 507, 537.

635. Reading and Writing in Content Areas (3) I II Methodology appropriate for reading and writing to learn content; compatible organizational models; program implementation. P. 504, 505, 507 or 551 or CR.

638. Reading Diagnostic Laboratory (3-6) [Rpt./6 units] I II Supervised practice in teaching reading diagnosis and criticism. P. 551.

639. Reading Instructional Laboratory (3-6) [Rpt./6 units] I II Supervised practice in teaching reading instruction; preparing and critiquing special instructional programs for students. Open to majors only. P. 507, 537.

653. Written Language Development (3) I II Study of handwriting and printing in the writing and reading development of preschool and school-aged children; relationships between reading and writing development explored through student research, applications to instruction. P. 505, 553.

694. Practicum a. Reading and Language (1-3) [Rpt./2 units] I 15 graduate units including 508 and 525.

696. Seminar a. Language, Reading and Culture (1-3) [Rpt./6 units] P. 5 P. 5 graduate units including 504, 505, 507.

b. Research in Bilingual Education (1-6) I II in Language and Literacy (1-6) [Rpt./3 units] I II

795. Colloquium a. Theory and Research in Language, Reading and Culture (1-3) [Rpt./5 units] I II P. 577.

796. Seminar a. Research and Evaluation in Language, Reading and Culture (1-3) [Rpt./5 units] I II P. 577.

Special Education and Rehabilitation (SER)

Education Building, Room 412

(602) 621-7822

Professors James C. Chalfant, Head, William C. Healey, Bob G. Johnson, Jeanne McRae McCarthy, Amos P. Sales

Associate Professors Shrin D. Antia, Candace S. Bos, Marilyn Jensen, C. June Maker, S. Mae Smith, John Umber

Assistant Professors Nancy Eldredge, Anthony K. Van Reusen

The division offers a program leading to the Master of Science degree with a major in rehabilitation. The division also offers programs leading to the Master of Arts, Master of Education, and Doctor of Philosophy degrees with majors in special education. The Doctor of Education and Doctor of Philosophy degrees are offered with majors in rehabilitation and special education. Concentrations are available within graduate majors offered in the division. Concentrations in special education are behaviorally disoriented, hearing impaired, early childhood handicapped, learning disabilities, mental retardation, multiple and severely handicapped, gifted, visually handicapped, emotionally handicapped, etc. Programs are designed to provide general rehabilitation counseling, rehabilitation psychology, counseling the deaf, counseling visual handicapped, corrected vision, and additional counseling. Concentrations in rehabilitation are general rehabilitation counseling, rehabilitation counseling, counseling the deaf, counseling the visually handicapped, corrected vision, counseling the learning disabled student, etc. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

At the time the catalog was being edited, revisions to many of the programs in the division were being considered for approval, with implementation anticipated for the 1989 fall semester. All current and prospective students should check with the Office of Student Services in the College of Education or the Division of Rehabilitation Counseling for information regarding the status and requirements of all programs and degrees.

500.* Introduction to Special Education and Rehabilitation (3) I II General characteristics of exceptional/disabled persons in interrelated human service delivery systems.

501.* Diagnosis and Remediation of Learning Problems (3) I II Procedures, methods, and strategies for informal diagnostic and remediation of children with learning problems in the academic areas of reading, spelling, handwriting, written expression and mathematics. Strategies and adaptations appropriate for use in the regular elementary or the special classroom.

502.* Behavior Principles for the Handicapped (3) I I Use of behavior principles to modify the behavior of handicapped persons, especially moderately and severely handicapped. CR 3R. 1R.


504.* The Bilingual Exceptional Learner (3) I Provides a theoretical base and practical approach to the study of special needs of the bilingual exceptional child; basic premises of bilingual special education and the interface of the two fields.

505.* Introduction to Learning Disabilities (3) I II Theories and history of programs for the learning-disabled—definition, characteristics, etiology. Degree candidates must complete 400/500 prior to taking 505.


507a-507b. Methods for Diagnosing Specific Learning Disabilities (3-5) I I Educational and psychological assessment of academic areas and learning processes involving perception, integration, and expression, with emphasis on informal and formal assessment and diagnostic teaching of the learning disabled student in secondary school; independent study; CR or permission of division; CR 593.

508. Teaching Learning Disabled Elementary Students (3) I II Preparation of academic areas and learning processes involving perception, integration, and expression, with emphasis on strategies for planning and implementing instructional programs at the elementary level. P. 405, 507a-507b, and permission division; CR 593 and 594.

509. Managing and Treating Severe Disabilities (3) I II History and philosophy of educational programs for the mentally retarded and other developmentally disabled; etiology, classification, and characteristics considered; educational, social, and psychological problems.

512. Teaching Learning Disabled Adolescents (3) I II Preparation for teaching the learning disabled adolescent at the secondary level. Emphasis on current intervention methods and practices. P. 400.

516. Nonoral Communication (3) [Rpt./3] I Techniques for assessment and intervention; alternative communication skills other than speech for students with severe disabilities; methods of instruction in nonoral communication skills for all ages; social interaction skills; augmentive communication aids.

520. Vision and Visual Functioning (3) I II Function and dysfunction of the eye; vision development, assessment and training; relationship of visual defects to learning and social adjustment.

522. Orientation and Mobility of the Visually Handicapped (3) I II Methods of teaching orientation and mobility skills to visually impaired and blind students. Emphasis on the school-aged child, with particular attention to concepts of orientation, development, assessment, and training; pre-cane ski personal safety, and independent ambulation including an introduction to long-car techniques.


524. Methods of Teaching the Visually Handicapped I III Curriculum development and adaptation in various educational programs for students with visual impairments. P. 524a Vision and Visual Compensatory Skills; P. 524b Assessment and Programming for use with blind and partially sighted children and youth; P. 524c Teaching academic and nonacademic skills to visually impaired students with nonhandicapped peers. CR. 593; P. 420.

530. Education and Rehabilitation of Hearing Impaired Individuals (3) I Current and theoretical perspectives: educational and rehabilitative services; etiology; impact on family, psychosocial, cognitive and intellectual development and functioning of hearing impaired individuals.

531a-531b. Advanced Sign Language I II Advanced principles, methods and techniques of American Sign Language and Manual Coded English; idioms, receptive skills regional variations.

532. Speech Development and Assessment Hearing Impaired (3) I II Development and speech and speech reception skills; assessment of speech intelligibility, articulator speech reading and auditory functioning; hearing impaired children. P. 430.

533.* Interpreting in Special Settings I II Classes will be offered on a rotating basis i areas such as educational, legal, medical, or MLC interpretation.

534. Language Development for the Exce-
55. Principles of Rehabilitation (3) I Principles underlying rehabilitation programs and the interdisciplinary nature of agencies engaged in rehabilitation services.

57. Administration 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 record. P, consult division before enrolling.

571. Supervision of Education (3) I Practical aspects of supervising special education programs and services; curriculum development, service delivery models, staff development, and legal and ethical issues.

572. Policy Analysis in Special Education (3) I Practical aspects of policy analysis and development in schools and other social agencies which serve the handicapped and the gifted.

575. Observation and Participation in Special Education Programs (1-3) I Specific types of exceptional individual, psychological and educational implications and practices.


582. Principles and Practices of Vocational Evaluation (3) I Understanding work skills and labor market conditions; process of vocational evaluation of rehabilitation clientele; collecting and synthesizing evaluation data and writing meaningful reports.

583. Counseling Practices in Rehabilitation Setting (3) I Facilitation training of rehabilitation professionals in their implementation of counseling practices with varied ethnic, age, disability, and educational populations. P, 1L, open to majors only.

584. Problems of Drug Abuse (3) I Survey course for teachers, counselors, and agency workers; comprehensive examination of drug abuse; drug abuse; work with research, examination of the community, cultural, and educational approaches to drug use and abuse.

585. Vocational Planning and Placement (3) I Problems of physical, mental, social, and emotional disability, as they relate to the formulation of a rehabilitation plan; exploration of the various sources of occupational and career choice information, job placement and development. P, 565, 580, 563 or CR.

586. Psychosocial Assessment of the Deaf Person (3) I Selection, administration, and interpretation of various psychosocial evaluation instruments used with deaf persons. P, Ed.P 673, 674A.

587. Construction and Development of Assessment Techniques (3) I Use of occupational information, career exploration and job analysis techniques; development, construction, standardization, and use of work samples and related vocational assessment techniques. P, 563, 565, 582.

588. Professional Problems in Rehabilitation Psychology (3) I Course will discuss professional problems commonly involved in rehabilitation psychology, focusing on the implications of research, publication, membership in professional organizations, including participation and presentation, legislation, monitoring the profession and defining new professional issues. P, 565.


590. Supervised Research in Exceptional Learners (3) I Review of principles and practices underlying applied research with exceptional learners; practice in preparation of research proposals; conduct of research emphasized.

593. Internship (1-12) I NOTE: Special sections in each concentration to be arranged in the division office.


595. Colloquium a. Substance Abuse Education (1) II b. Language Learning and Reading Disabilities (3) II (Identical with L.R.C. 595b) c. Severe Disabilities (3) I II P, 400.

596. Recent Advances in Special Education and Rehabilitation Psychology (3) I II Course will discuss professional problems such as research, publication, membership in professional organizations, including participation and presentation, legislation, monitoring the profession and defining new professional issues. P, 565.

597. Workshop a. Creativity and Giftedness (3) [Rpt/.9 units] I II...
1. Linear Systems Theory (3) I Mathematical descriptions of linear systems, state-models, analysis methods-stability, controllability and observability, state feedback design, design of feedback controllers and servers.


4. Instrumentation and Measurement (3) I Basic concepts of instrumentation and measurement; principles of transducers, operational amplifiers and instrument systems, with emphasis on biomedical applications; lab experiments with transducers, amplifiers, combos, and medical equipment. 2H, 3L.

5. Clinical Engineering (3) I Activities and responsibilities of clinical engineers; hospital medical equipment specifications and nontechnical aspects of safety and management and health care. Equivalents and conventional laser engineering (both thermal and athermal and other systems). 560.

6. Aerosol Science (3) I Introduction to aerosol science, filtration, evaluation of monitor structures, processing, simulation, ESD and latch-up protection, exercises and term project in design of a chip. P, 458.

7. Electronic Packaging Principles (3) I Future trends in packaging: thermal, mechanical, electrical and material design parameters. Additional information concerning this program for highly-qualified students with interests in research. M.S.E. 534.

8. Optical Sciences and Materials (3) I Optics: wave optical properties and components; design of optoelectronic devices, deapplications for science and technology. A.M.E. 517.

9. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

10. Image Processing - Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

11. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

12. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

13. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

14. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

15. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

16. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

17. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

18. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.

19. Image Processing: Devices, Systems and Applications (3) I Image processing; resolution; noise; linear processing; design and implementation of algorithms; maximum efficiency codes; nonlinear computer processing; coherent processing. P. 502 or background in theory of linear systems. Identical with Opti. 532.
578a-578b.* Data Communications Networks (3-3) 1 578a: Introduction to ISO open systems interconnection reference model, characterized network communication protocols, physical and data link layer functions and protocols, IEEE 802.2, 3, 4, 5 operation. 578b: Computer network performance evaluation, OSI network transport session layers, network standards, network software services, gateways, ISDN, and networking applications.


581. Electromagnetic Field Theory (3) II Methods used in solving electromagnetic problems of current importance such as appearing in IEEE transactions on microwave theory and techniques, antennas and propagation, and electromagnetic compatibility, and radio science. P. 502 or Math. 422b, E.C.E. 482 or Phys. 415b.

583. Remote Sensing Instrumentation and Techniques (3) II Development of instrumentation, measurement and signal processing techniques required for electromagnetic remote sensors. Emphasis on atmospheric remote sensing. P. 482.

584. Advanced Antenna Theory and Design (3) II 1990-91 Electromagnetic radiation and diffraction, antennas, open wave guides, and horns, apertures, reflectors, and arrays; mechanical and electronic scanning; applications to practical radar and communications problems.

585.* Radio Waves (3) II 1990-91 Geometrical ray tracing, diffraction and scattering, ground waves propagation, magnetionic theory, random media effects, topographic influences, satellite communications, and fiber optic transmission. P. 381.

586. Geo-Electromagnetism (3) I 1989-90 Earth resistivity principles, induced polarization, electromagnetic induction and loop-loop coupling, earth conduction effects in power systems, well logging, geometrics, magnetotellurics and tunnel transmission. P. 482; 502 or Math. 422b; Phys. 415b. (Identical with Geos. 586)

587. Plasma Etching (3) II 1990-91 Practical methodology of basic etch processes in silicon, silicon dioxide, silicon nitride, and aluminum layers; physics and chemistry, computer simulation. P. familiarity with processing techniques, or consult departmental literature.

589. Atmospheric Electricity (3) II 1989-90 (Identical with Atmo. 569)

615. Advanced Instrumentation and Measurements (3) II Instrumentation and measurement systems; measurement errors, noise reduction and amplifiers; emphasis on biomedical technology; research project on lab computer. 2R, 3L.

634. Electronic, Magnetic and Optical Materials (3) II (Identical with M.S.E. 634)

636. Information Theory and Coding (3) II 1990-91 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) 638. Communication and Information Theory and Signal Extraction (3) II 1989-90 Communication, detection and measurement as statistical decision problems; principles in the presence of noise; discussion of AM, FM, and PCM; matched filter and correlation detection; coherent detection, P. 503.


652. Advanced Solid-State Devices (3) II High-level pn-junction theory, BJTs and MOSFETS: modern device structures, advanced models. Microwave and photonic devices, P. 552.

653. Advanced Topics in Semiconductor Devices (3) I Preparation of approximately three one-hour presentations, including a formal written critique, on device topics of current interest. Topics selected require instructor's approval. P. 551 or 552.


657. Advanced Electromagnetic Engineering (3) I (Identical with N.E.E. 667)

673. Microprocessors, Minicomputers and Real-Time Distributed Processing (3) II Real-time distributed processing; structure of microprocessors and minicomputers. Applications to multiprocessor simulation, random-process measurements, and instrumentation. Multiprocessor sizing techniques. P. 475. (Identical with C.Sc. 673)

674. Sequential Circuits and Automata (3) I Analysis and synthesis of sequential circuits, partitioning and state assignment, linear sequential circuits, iterative networks, fault test generation and design automation. P. 474. (Identical with C.Sc. 674)

678. Integrated Telecommunication Networks (3) II Analysis and design of integrated voice, data, and image networks for integrated telecommunication systems. Protocols for LANs, ISDNs, and WANs and interoperable systems. Network software designs for ISO network works and applications. P. 574.


683. Principles of Atmospheric Remote Sensing (3) II 1990-91 (Identical with Atmo. 683)

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

687. Magnetic Confinement Controlled Fusion (3) II (Identical with N.E.E. 667)


693. Internship (1-3) I I P, enrollment in clinical engineering option.


Elementary Education (See Teaching and Teacher Education under Education)

Energy Systems Engineering (See Engineering)

Engineering (ENGR)

Geology Building, Room 134 (602) 621-6032

Within the colleges of Engineering and Agriculture, programs are offered leading to the Master of Science (M.S.) and the Doctor of Philosophy (Ph.D.) degrees as indicated in the following list of departments and majors:

Aerospace and Mechanical Engineering

aeronautical engineering 

agricultural engineering 

Civil and Environmental Engineering 

chemical engineering 

Civil Engineering and Engineering Mechanics 

civil engineering 

Computer Engineering 

electronical engineering 

Electrical and Computer Engineering 

electrical engineering 

Electrical and Computer Engineering 

electrical engineering 

Geological Engineering 

geological engineering 

Mining and Geological Engineering 

mining engineering 

Marine Engineering 

aeronautical engineering 

Materials Science and Engineering 

materials science and engineering 

Mechanical Engineering 

mechanical engineering 

Nuclear and Energy Engineering 

nuclear engineering 

Systems and Industrial Engineering 

systems engineering 

Biomedical Engineering: This option is available in the departments of Aerospace, Mechanical Engineering, Chemical Engineering, Electrical and Computer Engineering, Nuclear and Energy Engineering, and Systems and Industrial Engineering. Biomedical engineering is a multidiscipline in which physicians and engineers interact with life scientists and physicians to solve problems ranging from basic investigations to applications of systems to service facilities. Work is coordinated by the Committee on Medical Engineering.

Clinical Engineering: This option is available in the departments of Electrical and Computer Engineering and Aerospace and Mechanical Engineering. Clinical engineering can be defined as the application of engineering methods and technologies to the problems and needs of medicine and health care delivery. Clinical engineering implies bedside or pati
ed engineering and involves the use of the
ner’s background and skills as a part of
lotal health care team. The option includes
clic and elective course work, laboratories,
ais project, and a nine- to twelve-month
cal engagement in a hospital or medical
ergy Systems Engineering: This option is
able in the departments of Aerospace
chnical and Chemical Engineering, Chemical Engineer-
neering and Engineering
ics, Electrical and Computer Engineer-
uclear and Energy Engineering. The
ram is designed to encourage engineering
ary and current efforts directed toward
ety’s energy needs. The scope of interest
ides energy sources (fossil, geothermal,
uclear, and solar); systems to convert
er and power; efficient energy
; and environmental controls. Applied
nce and industrial interaction are stressed.
rogram is coordinated by a committee
ects in the departments in which the
on is available.
ineering Mechanics
en Languages Building, Room 445
essors Gerald Monsman, Head, Edward
bara Babcock, J. Douglas Can-
. L. Clark (Emeritus), Mary Jane
mer (Emerita), Roger Dahood, Edgar Dry-
, Sir William Epstein, Lawrence
ence J. Evers, Albert F. Gegenheimer,
rances Gillmor (Emerita), Byrd H. Granger
mer, Richard Hosley (Emeritus), Robert
. Hoyle, Hallie John Andrew Imman, Carl F.
eritus), Carl H. Ketcham, Carolyn
zer, Annette Kolodny, John H. McElroy,
ald M. McIver, N. Scott Momaday, A.
ace Moore Muir (Emeritus), Stephen L. Oli-
les E. Pomeran, Suresh Raval, Harry F.ins (Emeritus), Cecille Robinson (Emer-
us), Muriel Saville-Frakes, Ber-
der S. Scruggs, Richard Shelton, Oliver F.
igtworth (Emer-
., John C. Ulrey, J.P. Wearing, Peter Wild
al professors Susan H. Aiken, Jon
erson, Carl Berkhour, Roger Bowen, Alan
. Burke, Mary Carter, Charles E. Davis,
d Dye, Margaret B. Fleming, Roseann D.
soñez, Joy Harjo, Jerold E. Hogie, Arthur
. Lay (Emeritus), Frederick P. Kiefer, Gene
. Koppel, Peter E. Medine, Jane Miller, John
ills, Jonathan Penner, Frank P. Pia-ors,
uela Roen, Charles Sherry, Richard I.
. Myer, Thomas Willard
istant professors H. Douglas Adamson, Meg
ota Brown, Susan Derwin, Theresa Enos,
izalda Evans, Donna Johnson, Terry
chMillan, Thomas Miller, Tennanthony,
ace M. Senob (Emerita), Susan White,
ynda Zwinger
r department offers programs leading to the
er of Arts degree with a major in English or
n English as a second language, the Mas-
er of Arts degree with a major in creative wri-
 the Doctor of Philosophy degree with a
or in English or a major in English
ation.
ster of Arts (Major in English): To be admiss-
e, applicants must have completed the
ual of the undergraduate major in
ish with a grade-point average of at least
 in courses in English. Applicants must
m submit scores on the aptitude and advanced
iture in English tests of the Graduate Rec-
ord Examination and a short sample of their
ory or critical writing. Applicants must also
w to have the department receive
ree letters of recommendation. These mate-
rials should be addressed to the Director of
Graduate Study of the Department of English.*
Major in English as a second language): General Graduate Record Examina-
tion scores are required for students whose
grade-point averages are below 3.0. Applicants
must present three letters of recommendation
two years of college study in a foreign language
r demonstrated equivalent proficiency by exam-
ination.* Applicants must also present proof of
some prior teaching or tutoring experience.
Master of Fine Arts: For information concern-
ing this degree see Requirements for Master’s Degrees/Master of Fine Arts elsewhere in this
catalog.*
Doctor of Philosophy: The admission require-
ments for this degree program are the same as
those set forth for the Master of Arts with a
major in English. At least 30 but not more than
level work (beyond the requirements for the
Master of Arts degree) must be completed in
addition to the dissertation. All students must
pass a comprehensive examination prior to
final examination for the Master of Arts degree
ith high pass performance. All students for
the Ph.D. degree are required to pass the Ph.D.
reiminary examination with an acceptable score
acceptable to the Department of English.*
Details of specific departmental requirements for the various
degree programs should be obtained from the Director of
Graduate Study of the Department of English.*

1. Advanced Nonfiction Writing (1-4)
   [Rpt./2] I II P. 301

2. Business Report Writing (3) I II Study
   and development of written reports in business.

3. Introduction to Comparative Literature
   and Literary Theory (3) I (Identical with C.P.L.
   503a)

5. History of the English Language (3) I
   The evolution of English sounds, inflections,
   and vocabulary from earliest times to the present,
   with attention to historical conditions. (Iden-
   tical with Ger. 505)

6. Modern Grammar and Usage (3) I Current
   American English structure according to
type of grammar and current American
   English usage, both with reference to stan-
   dard models of English.

8. English as a Second Language in
   Bilingual Education (3) I II Methodology for
   teaching of English as a component of
   bilingual education, grammar, phonology,
   and syntax as they apply to the teaching of
   language skills.

10. Teaching of Composition (3) I II Theory
   and practice of teaching writing in secondary
   schools and colleges. P. 306

11. Teaching of Literature (3) I II Theory
   and practice of teaching literature, with inten-
   sive study of genres and works commonly
   taught in secondary schools. P. nine units of

12. Teaching of the English Language (3)
   I II Theory and practice of teaching various
   aspects of language in the secondary schools.
   P. 405/405b, 406/406b.

13. Poetry in Forms (1-4) [Rpt.] I II Explores
   the theory and practice of writing poetry
   and a wide range of poetic forms and techniques.
   P. 509

15a. Studies in the History of Criticism
   (3-3) 515a: Major works of criticism
   from earliest times to the present. P. 515b: Modern
   criticism.

15b. Theories of Linguistic Structure
   (3-3) 515b: The European tradition in linguistics.
   516b: Modern linguistics. 516a: The American tra-
   dition in linguistics. 516b is not prerequisite to 516a.

520. History of the German Language (3) 520:
   (Identical with Ger. 520)

525. Beowulf (3) I (Identical with Ger. 525)

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

530. The Anthology of Visual Art (3) I
   (Identical with Art. 530)

531. Advanced Studies in Shakespeare
   (3) I

533. Studies in the Renaissance (3) I

534. Advanced Studies in Milton (3) I

541. Preceptorship
   (Identical with Ger. 541)

549a-549b. Folklore (3-3) 549a: Forms of
   Verbal Folklore: myth, legend, folktale, riddle,
   proverb, joke, folk song, ballad, etc. 549b:
   Non-verbal Folklore: custom, belief, folk art
   and crafts, food, medicine, dress, festival, and
   drama. (Identical with A.In.S. 549a-549b
   and Art. 549a-549b)

551. Studies in Nineteenth-Century
   British Literature (3-3) 555a: The Romantics.
   555b: The Victorians.

566a-566b. Studies in Twentieth-Century
   British Literature (3-3) 566a: Modern British lit-
   erature. 566b: Contemporary British literature.

567. English Language (3) I (Identical with L.S.
   567)

568a-568b. Studies in American Literature
   to 1900 (3-3) 568a: To 1850. 568b: 1850-1900.

568c-568d. Studies in American Literature
   to 1990 (3-3) 568a: To 1850. 568b: 1850-1990.

577a-577b. American Literature in
   Transition (3-3) 577a: Modern American
   literature. 577b: Contemporary American
   literature.

578. Ethnic Literature
   a. North American Indian Literature. (3)
   (Identical with A.In.S. 577a)

585. Linguistic and Computer-assisted
   Approaches to Language (3) [Rpt./6 units] I
   (Identical with Ger. 585)

591. Preceptorship
   a. Methodology of Essay Writing (1) I
   Designed for graduate teaching assist-
   ants in English.
   b. Methodology of Critical Reading and
   Writing (1) I Designed for graduate
   teaching assistants in English.

595. Colloquium
   a. Rhetoric of Exposition (1) I Designed
   for graduate teaching assistants in English.
   b. Rhetoric of Literature and Critical Writing
   (1) I Designed for graduate teaching
   assistants in English.

599. 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. Eighteenth-Century British Literature
   (3) [Rpt.] I II
   e. Nineteenth-Century British Literature
   (3) [Rpt.] I II
   f. Twentieth-Century British 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. Creative Writing (3) [Rpt.] I II (Identical
   with Ger. 595)
   j. Second Language Acquisition Research
   (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)
The department offers programs leading to the Master of Science and Doctor of Philosophy degrees in entomology. Disciplinary specializations are available in agricultural entomology, aquatic entomology, agriculture, behavior, biological control, biometrics, ecology, host plant resistance, insect pest management, medical and veterinary entomology, morphology, physiology, toxicology, and toxicology. Entomology research opportunities also exist in the Department of Biochemistry and the Committee on Neurobiology.

Admission requirements include the completion of an undergraduate major in entomology or equivalent degree in the biological sciences. The undergraduate program should include coursework in the biological sciences, physics, organic chemistry, and mathematics. Applicants must submit scores on the general and subject tests of the Graduate Record Examination and three letters of recommendation from persons in a position to assess the applicant's potential as a graduate student. Inquiries concerning financial aid should be addressed to the department.

Graduate study programs are individually planned and approved by the guidance committee. All candidates, regardless of the area of concentration, will be required to have completed courses in systematics, morphology, and physiology. A thesis is ordinarily required. The doctoral program requires, in addition to the requirements for the master's degree, coursework in biochemistry, computer programming, advanced statistics, and the equivalent of one semester of teaching experience.

503R. *Biological Control of Insects and Arthropods* (3) Identical with Tox. 508
503T. *Parasitology Laboratory* (1) Identical with Tox. 503T
507. *Insect Physiology* (4) 1990-91 Introduction to the diverse and unique ways insects solve problems of reproduction, nutrition, and defense. A whole-animal approach will be used centered around various aspects of an insect's life (i.e., growing, flying, reproducing). Laboratory will expose student to modern techniques of experimental analysis. P, biological chemistry recommended. Hagedorn
508. *Insecticide Toxicology* (3) 1989-90 Insecticides and related chemicals; their modes of action, detoxification, resistance in arthropods, and environmental distribution and effects. P. 3 units of organic chemistry or biochemistry. (Identical with Tox. 508)
512. *Insect Behavior* (3) 1989-90 The evolution of arthropod behavior in ecological context. Ultimate causation with some consideration of physiological and morphological constraints. 2R, 3L. Field trips. (Identical with Ecoc. 512) Smith
516. *Insect Systematics* (4) 1989-90 Principles and methods of insect systematics. Practice in identification of adult and immature insects and the construction of practical classification for the field recognition of species present in crop plantings and other delimited habitats. 3R, 3L. Field trips. Werner
543. *Insect Neurobiology* (3) 1989-90 The structure, function and development of the insect nervous system. Comparative concepts in neurobiology and presentation as insects as model systems of neurophysiology, development and behavior. P. Ecoc. 181, 182 or two courses in biochemistry. P, Ecoc. 181, 182. P. Werner
544. *Insect Ecology* (3) 1989-90 Determinants of population size and distribution, including processes occurring within and between populations, abiotic factors. 2R, 3L. Field trips. P. one course in entomology or Ecoc. 182. (Identical with Ecoc. 544) Moran
552. *Medical-Veterinary Entomology* (4) [Rpt/3] Survey of arthropods of public health and veterinary importance, with emphasis on transmission dynamics of pathogens, biocides, vector populations and current control concepts. 3R, 3L, 201. Parasitology recommended. (Identical with V.Sc. 552)
558. *Agricultural Entomology* (3) Principles underlying the management of arthropods in agricultural systems. Identification, sampling of animals, damage. 2R, 3L, P, one course in entomology. P, Ecoc.
570. *Biological Control* (3) Principles of the biological control of arthropod pests and weeds, emphasizing their application to agricultural and rangeland entomology. P, 444 and 468. Watson


*Future Staff Members*

- Associate Professor Terry Daniel (Psychology), William Have (Renewable Natural Resources), Willis Tetterson (Psychology), David King (Renewable Natural Resources), Kirby Lockard (Architecture), William Rathe (Anthropology), Thora F. Saarinen (Geography), Lawrence Whee (Psychology), Ervin H. Zube (Renewable Natural Resources)

- Associate Professors Dennis Doxtater (Architecture), William Shaw (Renewable Natural Resources)

- Assistant Professor Robert Itami (Renewable Natural Resources)

The Committee on Environment and Behavior functions to coordinate and further develop study of the relationship between physical surroundings and human activities. The multidisciplinary group of teachers and researchers assist students interested in combining environmental and behavioral emphasis in majors such as psychology, architecture, landscape architecture, interior design, geography, renewable natural resources, political science, and water resources administration. Interested students should consult their department advisors and appropriate members of the Committee on Environment and Behavior.

While no graduate major is offered, the committee does offer a doctoral minor. A minimum of fifteen units from environment and behavior courses approved by the committee are required.

Current information on studies in environment and behavior can be obtained from the chairperson, Committee on Environment and Behavior, Department of Psychology. Counsel identified as having content which deals specifically with environment and behavior include Arch. 287, 474, 529, 597; Art. 434; Geog. 287, 360, 507, 561, 563; Idts. 586U; L. Ar. 533, 568; N.R.R. 470, Pol. 581; Psych. 371, 521A-521B, 571, R.N.R. 565, 595C.

Ethnic Studies

(See American Indian Studies)
...estic companies.

Dcedures for master's programs with a major in other fields. Counseling and Guidance are obtainable on ling. A minor program of fifteen units mini-

er's programs leading to the Master of Arts degree. Concentrations are available in career counseling and guidance, human development, or family economics/consumer resource management.

Students are accepted into the concentration in Family Studies within the Family and Consumer Resources major for the Ph.D., it is assumed that all have the ability and interest to pursue the doctoral degree and are expected to meet all university requirements for doctoral studies with a major concentration in family studies and a minor from an area outside the School of Family and Consumer Resources.

Home Economics Education: Programs leading to the Master of Science degree and the Master of Science in Economics Education degree with a major in home economics education are available. A minor in home economics education is also available for doctoral students with majors in other disciplines. The Master of Science degree program requires a thesis and no fewer than twenty units in home economics education, family and consumer resources, 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.

Requirements for the degree include two units of seminar, an appropriate course in statistics, a course in research methods, and a thesis of four units. Additional 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.

Interior Design: The Interior Design graduate program is designed primarily to accommodate outstanding graduates of interior design or design-related programs. It is flexible in concept to meet the needs and interests of students who desire advanced, specialized research in interior design and related fields.

For admission consideration, applicants must have completed a grade-point average of 3.0 or higher, an undergraduate program substantially equivalent to the Interior Design program at the University of Arizona. Applicants without this design background will be required to complete additional undergraduate coursework as defined by the department. Master's degree applicants must submit a personal data blank, a statement of professional objectives, home economics education, interior design;

aster of Science with a major in home eco-

comics education;

aster of Education with a major in family and consumer resources;

aster of Arts with a major in counseling and guidance;

ctor of Philosophy with a major in family and consumer resources and a concentra-
tion in family and consumer resource management.

J. applicants are required to submit scores on the aptitude test of the Graduate Record Examination, three letters of reference, and a statement of academic and professional goals. Other requirements are given in the notes for each program area below.

gram Areas:

thing and Textiles

suming and Guidance

ly Studies

omics Education

ior Design

grams

thing and Textiles: For the Master of Science degree in home economics/consumer resource management is available in home and textiles. 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 promotion and educational or testing positions with industrial and commercial companies.

Consumer Studies: A program leading to the Master of Science degree with a concentration in family economics/consumer resource management is available. Requirements to be included in the graduate study are: 30 units in the major area including statistics and research methods plus four to six units for the thesis. This program prepares students for a variety of careers in family economics/consumer resource management.

Consumer Studies: Program areas leading to the Master of Arts degree. Concentrations are available in career counseling and guidance, family, marriage, and agency counseling. A minor program of fifteen units minimum is acceptable for doctoral students majoring in other fields.

Forms and statements regarding application procedures for master's programs with a major in counseling and guidance are obtainable on request from the department. Master's degree applicants must submit a personal data blank, a statement of professional objectives, home economics education, interior design;

aster of Science with a major in home eco-

comics education;

aster of Education with a major in family and consumer resources;

aster of Arts with a major in counseling and guidance;

ctor of Philosophy with a major in family and consumer resources and a concentra-
tion in family and consumer resource management.

J. applicants are required to submit scores on the aptitude test of the Graduate Record Examination, three letters of reference, and a statement of academic and professional goals. Other requirements are given in the notes for each program area below.

gram Areas:

thing and Textiles

suming and Guidance

ly Studies

omics Education

ior Design

grams

thing and Textiles: For the Master of Science degree in home economics/consumer resource management is available in home and textiles. 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 promotion and educational or testing positions with industrial and commercial companies.

Consumer Studies: A program leading to the Master of Science degree with a concentration in family economics/consumer resource management is available. Requirements to be included in the graduate study are: 30 units in the major area including statistics and research methods plus four to six units for the thesis. This program prepares students for a variety of careers in family economics/consumer resource management.

Consumer Studies: Program areas leading to the Master of Arts degree. Concentrations are available in career counseling and guidance, family, marriage, and agency counseling. A minor program of fifteen units minimum is acceptable for doctoral students majoring in other fields.

Forms and statements regarding application procedures for master's programs with a major in counseling and guidance are obtainable on request from the department. Master's degree applicants must submit a personal data blank, a statement of professional objectives, home economics education, interior design;
550. Counseling and Human Sexuality (3) S
Sexual function, dysfunction, and disorders in context of individual and couple; interview techniques and intervention strategies.

555. Addictions Counseling (3) S
An analysis of issues in addictions counseling ranging from theoretical positions, information regarding diagnosis of addictive personality, treatment programs, and research. P, 6 units of counseling or related area.

557. Methods in Marital Therapy (3) I (Identical with F.S. 557)

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
Interdisciplinary human relations training lab, for assessment and development of communication and interpersonal skills. Applications in the home, business, educational and community settings.

589. Workshop
C. Self-Management Techniques (3) S
J. Anger, Depression and Guilt (3) S
K. Alcohol Abuse (3) S

601. Foundations of Counseling (3) I
Relationship and contributions of various fields to the work of the counselor at all levels, in current and historical perspective; derivation of principles and objectives; integrated lab. experience in selected settings. Open to majors only.

622. Appraisal of the Individual (3) II
Methods of appraising and reporting individual behavior, with emphasis on nonsympathetic data. Open to majors only.

623. Testing in Counseling (3) I
Evaluation and selection of psychological tests for guidance; use of psychometric data in counseling. Open to majors only.

631. Career Counseling (3) I
Theories of vocational development; types, sources, and use of occupational and educational information in career counseling and decision making. P, or CR, 531.

640. The Counseling Process (3) I
Introduction to theories of counseling; collation and interpretation of counseling data; the counseling process in cases. P, 591, 622.

645. Theories of Counseling (3) II
Rationale, development, and research underlying major counseling theories. P, 631, 644.

647. Marriage and Family Counseling (3) I
Contemporary issues, concepts, and procedures in premarriage and marriage counseling. P, 591, 622.

648. Process in Family Counseling (1-3) I
Theory and process in family counseling; problem solving techniques applied to parent-child conflict; lab. experience. P, 591, 622.

649. Procedures in Marriage Counseling (3) I
Application of counseling theory and techniques to the diagnosis of marital relationship and strategies for behavior change. P, 523, 591, 622.

672. Cross-Cultural Counseling (3) I
Issues, research and procedures involved in counseling with culturally different persons. Open to majors only. P, 601, 622.

683. Group Counseling (3)
Theory and process in group counseling; applications in school, college, and community settings; lab. experience. P, 564.

693. Internship
A. Counseling (1-9) [Rpt.] I
B. Practicum P, 24 units of counseling courses. Supervised practice is offered on the basis of need and demand in the following areas:

- Agency Counseling (1-9) [Rpt.] I
- Family Counseling (1-9) [Rpt.] I
- Group Counseling (1-9) [Rpt.] I
- Marriage Counseling (1-9) [Rpt.] I
- Professional Practice (3) [Rpt.] I
- Counseling Theory (Theory varies) (1-3) [Rpt.] I
- Career Development (1-3) I

Family Studies (FS)
T. Jacob, Program Leader

500. Life Span Development (3) II (Identical with Ed.P. 500)

503. Advanced Adolescent Development (3) II (Identical with Ed.P. 503)

507a-507b. Research Methods in Social Science (3-3) I
II 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.

547. Theories of Family Development (3) I
Analysis and integration of the major theories of individual and family development within a social context; evaluation of theoretical formulations. P, 573.

557. Methods in Marital Therapy (3) I
Theories and principles of counseling for premartial, marital, and group counseling situations. (Identical with Coun. 557)

559. Family Development (3) I
Internal development of families over the life cycle, with emphasis on family goals, structure and functioning in the context of American society. P, 573, Soc. 100, Psyc. 101.

610. Topics in Child Development and Family Relations (1-3) I
II Variable content: cognitive development, biological theories of development, role theory, middle childhood, and others.

637. Trends in Human Relations (3) I
Philosophy, content, and resources for understanding, teaching and working in the field of human relations.

Home Economics Education (HEE)
E. Sproles, Program Leader

590. Occupational Home Economics Programs (3) I

628. Professional Presentations and Techniques (3) I
Theory and practice of educational techniques in non-formal settings in positions in business, government and human services. 2R, 3L.

638. Philosophy and Principles of Extension Education (3) I (Identical with A.Ed. 536)

539. Extension Education Methods (3) II (Identical with A.Ed. 539)

597. Workshop
C. Extension Credibility and Accountability (1-2) [Rpt./2] (Identical with A.Ed. 597c which is home)
D. Administration, Management, and Supervision of Cooperative Extension (1-2) [Rpt./2] (Identical with A.Ed. 597d which is home)
G. Microcomputers-Extension (1-2) [Rpt./2] (Identical with A.Ed. 597g which is home)
H. Family Development through Home Economics (1-2) I
I. Video Communications and Methods (1-2) [Rpt./2] (Identical with A.Ed. 597i which is home)
M. Personal Effectiveness: The Human Factor (1-2) I (Identical with A.Ed. 597m which is home)
N. Public Policy Issues (1-2) I (Identical with A.Ed. 597n, which is home)
R. Public Relations in Extension (1-2) [Rpt./2] (Identical with A.Ed. 597r, which is home)
S. Family Development through Home Economics (1-2) II

607. Topics in Home Economics Education (1-3) [Rpt./2 units I] S Philosophy, content, resources for understanding, teaching, and working in home economics 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 projects.


Family Economics and Home Management (See Family and Consumer Resources)

Family Relations (See Family and Consumer Resources)

Finance and Real Estate (FIN)
Harvill Building, Room 226
(602) 621-7554

Professors Edward A. Dyl, Head, Gerald Bierwag, Willard T. Carleton, Nestor R. River (Emeritus)
Associate Professors Erich K. Bleck, Joseph Gerber (Emeritus)
Financial decision-making in corporations.
Financial Markets (3) [Rpt./1] I
C. Corporate Finance (3) [Rpt./1] II
Financial Institutions (3) [I]
Financial Theory (3) [Rpt./1] II
Research Methods (3) [Rpt./I] II

Food Science
(See Nutrition and Food Science)

Foundations of Education
(See Educational Foundations and Administration under Education)

French and Italian (FRE/ITA)
Modern Languages Building, Room 549 (602) 621-7349

Professors Jonathan Beck, Head, Guido Capponi (Emeritus), Frank M. Chambers (Emeritus), Jean-Jacques Demores (Emeritus), Associate Professors Bert Ahier, Edward G. Brown, Ingeborg M. Kohn, Herrn Servin, Gianni Spera, Ronnie H. Terpening Assistant Professors Irene D’Alimeda, Lise Lebèche

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in French. In cooperation with the College of Education, the department also offers courses leading to the Master of Education degree with a major in French. For information regarding this degree see Requirements for Master’s Degrees/Master of Education elsewhere in this catalog. A doctoral minor is available in French and in Italian.

The department offers courses through the Arizona Center for Medieval and Renaissance Studies. Admission to graduate programs in French requires the completion of a bachelor’s degree with a major in French. Applicants must submit scores on the aptitude test of the Graduate Record Examination. Admission to a doctoral program is dependent upon the completion of a Master of Arts degree with a major in French. Students with a master’s degree from another institution must take a qualifying examination during the first two weeks of residence.

Degrees
Master of Arts (Major in French): Students must complete at least 32 units of course work. A thesis is not required. Concentrations are available in the literature of France and Francophone literature. Candidates must pass a final written and oral examination.

Doctor of Philosophy: The major in French consists of a minimum of 50 units of graduate course work in the department in addition to the dissertation. The minor, consisting of 15 or more units, may be taken within the department or in a field approved by the department. All students are required to demonstrate knowledge in two other foreign languages. After successful completion of the written and oral preliminary examination, each candidate will write and defend a doctoral dissertation.

French
500. Intensive Reading Course for Graduate Students (3) (3) [I] I
510. Introduction to Graduate Study in French Language and Literature (3) I 1989-90

Problems and methods of advanced research in French language and literature. Use of specialized library resources and computerized data bases. Issues in the history, sociology, and politics of the professional practice of language and literature study in American institutions.

511. Contemporary French Literary Theory (3) II 1989-90 Methods of criticism and techniques of literary analysis.

614.* Teaching of Modern Languages (3) (Identical with Span. 522)

515a-515b. Literature of the 20th Century (3-3) 1990-91 515a: Novel. 515b: Poetry and drama. 515a is not prerequisite to 515b. 515a-515b. Literature of the 19th Century (3-3) 1990-91 516a: Poetry and theatre. 516b: Novel and short story; intellectual current. 516a is not prerequisite to 516b.

517a-517b. Literature of the 18th Century (3-3) 1989-90 Study of ideas in the French Enlightenment. 517a: Rationalist currents. 517b: Sensibility. 517a is not prerequisite to 517b.

518a-518b. Literature of the 17th Century (3-3) 1990-91 518a: Literature and culture in the first half of the 17th century. 518b: The classical era. 518a is not prerequisite to 518b.

519a-519b. Literature of the 16th Century (3-3) 1989-90 519a: Early Renaissance. Reformation, Rabelais, the Pleiade. 519b: The Humanists, Montaigne, D’Aubigné, the drama. 519a is not prerequisite to 519b.

520a-520b. Old French Language and Literature (3-3) 1990-91 520a: Old French language. Taught in English. 520b: Medieval French literature.

522.* Introduction to Romance Philology (3) (Identical with Span. 522)

523. Contemporary French Philosophy (3) II 1989-90 Discussion course, with readings in the works of Bergson, Camus, Simone Weil, Teilhard de Chardin, Sartre, Levi-Stauss, and others.


551.* Literature of the Fantastic (3) [Rpt./6 units] II 1989-90 Study of aspects of the supernatural, the unexpected, the unexplainable in French literature; analysis of dominant themes and important authors, from the Middle Ages through the 20th century. Content varies. P, 350.


553.* Culture and Civilization of North Africa (3) 1990-91 Historical, religious, social, literary and artistic influences on the civilization of North Africa. P, 555b if taught in French.

554.* Francophone Literature of the Maghreb and the Maghreb (3) II 1990-91 Francophone literature of Algeria, Lebanon, Morocco and Tunisia. P, 555b if taught in French.

555. Rousseau (3) II 1990-91 Rousseau’s political thought; his ideas concerning education; The Confessions; the beginning of Romanticism.

556.* Realism and Naturalism in the Novel (3) 1989-90 Flaubert, Zola, Maupassant, etc.

559. Contemporary Theatre (3) II 1990-91 Theatre from 1950 to the present time; Ionesco, Beckett, Genet, Arrabal, Obaidia, Tardieu, Dubillard, etc.

579. Problems in Teaching College French (1-3) I II Methodology course in lower-division French pedagogy. Discussion of the major issues of language, pedagogy, academe, the history of foreign language education, college teaching as a career.

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

*May be convened with 400-level course.
515. Somatic Cell and Molecular Genetics (2) (Identical with M.C.B. 515)
520. Historical Genetics (1) I 1990-91 Experiments and discoveries that have led to the present state of knowledge in the various areas of genetics. P. Ecol. 320 or 321.
523. * Cyto genetics (3) II (Identical with Ecol. 523)
524. Theoretical Population Genetics (3) I (Identical with Ecol. 524)
525. Special Topics in Genetics (1) (Identical with Ecol. 525)
528R. * Advanced Microbial Genetics (3) II (Identical with M.C.B. 528R)
535. * Evolution (3) I (Identical with Ecol. 535)
537. * Statistical Methods (4) I (Identical with A.Ec. 539)
555. Molecular Mechanisms of Development (3) I 1990-91 (Identical with M.C.B. 555)
566. Nucleic Acids (3) II (Identical with Bioc. 566)
570. Molecular Genetics (3) I 1989-90 (Identical with M.C.B. 567)
571. Molecular Gene Cloning (3) II 1990-91 (Identical with Micr. 571)
573. * Recombinant DNA Techniques (3) II (Identical with M.C.B. 573)

May be counted toward a 500-level course.

595. Colloquium
a. Genetics (1) [Rpt.] I II
596. Seminar
i. Cancer Genetics and Cyto genetics (3) I 1989-90 (Identical with C.Bio. 5967, which is home)

620. Human Genetics (3) I Genetic theory and technique, as applied to man; methods of analysis of genetically determined cytological and biochemical differences in individuals and populations. 2R, 3L. P. Ecol. 320 or 321. (Identical with Ecol. 620) Ward
627. Advanced Genetics (3) I 1990-91 (Identical with Pls. 627)
635. Advanced Cyto genetics (4) II 1990-91 (Identical with Pls. 635)
638. Genetics of Plant Cell Cultures (2) I 1990-91 (Identical with Pls. 638)
666. Human Microevolution (3) II 1990-91 (Identical with Anth. 666)
670. Recent Advances in Genetics (2) I Recent advances in the field of genetics. (Identical with Ecol. 670)

Geography and Regional Development (GEOG)
Harvill Building, Room 437
(602) 621-1652

Professors Terence Burke, Robert D. Carpenter (Emeritus), Lay J. Gibson, Lawrence D. Mann, Jelan R. Pederson, Richard W. Reeves, Thomas F. Saarinen, Dan Stanislawski (Emeritus), Andrew W. Wilson (Emeritus), Ervin H. Zube (Renewable Natural Resources)
Associate Professors Gordon F. Mulligan, Head, D. Robert Altschul, Michael E. Bonine (Oriental Studies), Andrew M. Kirby, David A. Plane Assistant Professor Sallie A. Marston

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in geography. In cooperation with the College of Education, the department offers work leading to the Master of Education degree with a major in geography. The department also offers work in regional planning leading to the Master of Science degree with a major in planning.

All applicants must submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Admission to the Doctor of Philosophy degree program requires the recommendation of the committee administering the final examination for the Master of Arts degree or, if the master degree was earned elsewhere, admis ssion subject to passing the General Examination during the first semester of resident grad study.

Degrees
Master of Arts: A total of 30 units of graduate credit, to include (1) a core of 9 units made of 500, 567, and 689; (2) a minimum of 12 units of graduate work in geography excluding both core and thesis, at least 6 of which must be in courses or seminars exclusive to graduate credits and (3) at least 12 units of approved electives, which must include up to 6 units of thesis, which is optional. Students selecting the thesis option must pass final oral examination; those electing the research option must pass a written and oral comprehensive examination.

Master of Science: A total of 17 units of approved graduate course work, to include at least a regional and one topical course. No thesis required, but candidates must pass a 3-hour written examination and oral examinat. For further information concerning this degree, see Requirements for Master's Degrees and Master's Degrees elsewhere in this catalog.

Master of Science: A total of 11 units of approved graduate course work, to include at least a regional and one topical course. No thesis required, but candidates must pass a 3-hour written examination and oral examination. For further information concerning this degree, see Requirements for Master's Degrees and Master's Degrees elsewhere in this catalog.

Doctor of Philosophy: Doctoral students must complete the requirements for the master degree and in addition a minimum of 18 units of graduate work (exclusive of research) which at least 12 units must be in courses seminars exclusive to graduate students, i.e., not convening 400/500 courses, and not independent studies. Students must also acheive high-level competence in two fields of concentration, one topical and one regional. A student will ordinarily complete a minimum of six units in each. Topical concentrations are available in behavioral, cultural, economic, historical, physical, and urban geography, and in regional development. Requirements are available in Anglo-America (or United States), lands, and Latin America. At least one research tool (e.g., language, statistics/computer analysis) is required for the Ph.D. degree. This requirement may be met by one of four options: a reading knowledge of French or German or other approved language; high proficiency in the use of one approved language; a reading knowledge of one approved language; a completion of an 11-unit sequence in statistics/computer science; a high proficiency in mathematics/statistics/computer science gained by completion of a 17-unit related course sequence. This is a minimal requirement subject to approval by the student's supervisory committee. The minor or minors must be complementary to the student's program specialization, and the dissertation should incorporate aspects of both regional and topical concentrations chosen.

502. * Introduction to Water Resources Policy (3) II (Identical with W.R.A. 502)
577. * The Anthropology of Nature and the Natural Sciences (3) I II Character and the visual aspects of plant views internationally and regionally; change habitat, vernacular structures and landscape patterns. Independent study. Includes trips. Field trips. (Identical with LAr. 507) Zube
565. Isotope Geology (3) II Theory and application of light stable isotopes to petrological, ore deposition, and geothermal problems. Long

566. Botanical Basis of Dendrochronology (3) II 1989-90 Examination of the environmentally modified processes of developmental tree physiology and wood anatomy and their application to correlation and analysis. Field trip. (Identical with Ws.M. 566) Midlak


568. Advanced Seismology (3) II 1989-90 Computational techniques in seismology. The application of synthetic seismograms to model source processes and complex structure. P, 432; Math. 422b. Wallace


570. Introduction to Paleoclimatology and paleoecology approaches to the reconstruction of ancient environments, populations and communities. Evolution of climates through geologic time. 2R, 3L. Field trips P, 225, 302. Flessa


573. Geology and the Urban Environment (3) II Geologic processes that result in the loss of life and property damage; emphasis on case studies of urban areas in the Southwest. Implications for public policy. 2R, 3L. All-day field trips. (Identical with Ping. 573) McCullough


4. Evolution of Planetary Surfaces (3) II 30-91 (Identical with Phy.S. 561)


6. Quantitative Dendrochronology (3) I 90-91 Analysis of tree-ring and other ophic data series using a wide variety of statistical and time-series techniques. Comparison of tree-ring data series with various climatological and hydrological records for the exploration and reconstruction of past variations. 2R, 3L. P, 464a-464b or 564a-564b, Stat. 461 (Identical with Ws.M. 556) Stockton

7. Low Temperature Geochemistry (3) II Glacial and Quaternary Geology (3) II Glacial processes, landforms, and deposits. Yasic aspects of Quaternary paleoenvironmental change and effects on fluvial, eolian, lacustrine, and coastal deposits. P, 101, 104. Baker

8. Electrical Methods (3) I Identical with G.En. 560

11. Paleoindian Origins (3) I (Identical with G.En. 551)


13. Isotope Hydrology (3) I Theory and applications of stable and cosmogenic isotopes to hydrological and paleoenvironmental problems. Radiometric dating of ground water. Synch with Hydrl. 563z Long

14a.566. Botanical Basis of Dendrochronology (3) I Survey of dendrochronological methods. Applications to archaeological, botanical, and biological dating and paleoclimatic reconstruction. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from in situ contexts. 2R, 3L. Field trips. (Identical with Anth. 564a-564b and Ws.M. 564a-564b) wrenam

596. Seminar I a. Petrography-Petrology (1-4) [Rpt.6 units] II b. Structural Geology (1-4) [Rpt.6 units] II c. Mineral Deposits (1-4) [Rpt.6 units] II d. Petroleum Geology (1-4) [Rpt.6 units] II e. Tectonics (1-4) [Rpt.6 units] II f. Mineralogy-Crystallography (1-4) [Rpt.6 units] II g. Vertebrate Paleontology (1-4) [Rpt.6 units] II h. Paleontology (1-4) [Rpt.6 units] II i. Paleoecology-Paleoenvironments (1-4) [Rpt.6 units] II j. Paleomorphology (1-4) [Rpt.6 units] II k. Geometrics (1-4) [Rpt.6 units] II l. Geomathematics (1-4) [Rpt.6 units] II m. Sedimentology (1-4) [Rpt.6 units] II n. Stratigraphy (1-4) [Rpt.6 units] II o. Tectonics (1-4) [Rpt.6 units] II p. Hydrogeology (1-3) [Rpt.6 units] II q. General Geochronology (1-4) [Rpt.6 units] II r. Quaternary Geochronology (1-4) [Rpt.6 units] II s. Sedimentary Petrography (1-4) [Rpt.6 units] II t. Organic Geochemistry (1-4) [Rpt.6 units] II u. Inorganic Geochemistry (1-4) [Rpt.6 units] II v. Dendrochronology (1-4) [Rpt.6 units] II w. Paleoecology (1-4) [Rpt.6 units] II x. Paleobotany (1-4) [Rpt.6 units] II y. Role of Water in Geologic Processes (1-4) [Rpt.6 units] II z. Geophysics (1-4) [Rpt.6 units] II


645a-650b. Advanced Ore Deposit Geology (4-8) Case studies of methods and theories used in recognition and evaluation of ore deposits in igneous, sedimentary, and metamorphic rocks. Labs. include field trips, analytical techniques, problem solving. 2R, 5L, P, 446, 450, Chem. 490a or CR. Tilley/Guilbert

650. Field Studies in Geomorphology (3) I 1989-90 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 1990-91 Effects of tectonic movements and climatic changes on geomorphic processes, landforms, and soils; paleoclimatic and earthquake-hazard interpretations. 2R, 3L. Field trips (includes spring break field trip). Bull


German (GER)

Modern Languages Building, Room 571 (602) 621-7385

Professors Renate A. Schulz, Head, David H. Chisholm, Max Dufner (Emeritus), David J. Woloshin (Emeritus)

Associate Professors Dennis L. Greene, Babette Luz (Emerita), Steven D. Martinson, Roland Richter

Assistant Professors Albrecht Classen, Mary Wildner-Bassett

The department offers a program leading to the Master of Arts degree with a major in German. In cooperation with the College of Education, the department also offers work leading to the
Master of Arts degree with a major in German. For information on this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Studies are available in the various areas of Germanic philology and culture in their more modern and contemporary aspects as well as in earlier historical and linguistic developments. Courses are also available in second language acquisition and testing for a minor option in the M.A. degree in German.

Prequisite for admission to the graduate program is the completion of at least 16 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. 610 is required of all master's candidates; Ger. 579 is required of all teaching assistants.

M.A. Thesis Option: Students may be permitted to write a thesis upon application to and consent of the Departmental Graduate Committee. Students approved for the thesis option must complete the 24 unit course work requirement (excluding 910). No more than six units may be used for writing the thesis; thesis students enroll for Thesis 910.

The student must pass both a written and an oral comprehensive examination. Prior to this examination the student must either have passed 575a or 575b successfully or give evidence of an equivalent proficiency in the use of written German and must rate Superior on the ACTFL/ETS Oral Interview Test or an equivalent test.

500. Intensive Reading German for the Sciences and Humanities (4 hrs/wk, no credit) S

Rapid acquisition of reading proficiency in German. No prior knowledge of German is necessary. Proficiency certification obtained from this course fulfills foreign language requirement in some departments. Consult department for information.

501. German Lyric Verse from the Renaissance through Classicism (3) II 1990-91 Introduction to the principles and forms of poetry; analysis and interpretation of outstanding examples of German lyric verse from the Renaissance through the 18th centuries. P, 6 units of upper-division German. Chisholm

502. German Lyric Verse from Romanticism to the Present (3) I 1989-90 Introduction to the principles and forms of poetry; analysis and interpretation of outstanding examples of German lyric verse of the 19th and 20th centuries. P, 6 units of upper-division German. Chisholm

503. Eighteenth-Century German Literature (3) II 1989-90 Kloopstock, Lessing, Wieland, Goethe, Schiller, Hoelderlin and other authors. P, 6 units of upper-division German. Martinson

504. German Romanticism and Realism (3) I 1990-91 Readings and discussions of representative works of German lyric verse from 1775 to 1848. P, 6 units of upper-division German. Richter

505. *History of the English Language (3) (I) (Identical with Engl. 505)

506. German Literature from 1848 through Naturalism (3) I 1989-90 Readings of major prose and dramatic works of the second half of the 19th century, in German. P, 6 units of upper-division German. Martinson

507. Goethe's Faust (3) II 1990-91 A close reading of the poem and an introduction to some of the critical secondary literature. P, 6 units of upper-division German. Martinson

509. German Literature from 1900 through the Weimar Republic (3) I 1989-90 Readings of major prose and dramatic works between 1900 and 1933, in German. P, 6 units of upper-division German.

510. German Literature from 1933 to the Present (3) I 1990-91 Readings of major prose and dramatic works after 1933, in German. P, 6 units of upper-division German.

511. Middle High German (3) II 1990-91 Introduction to Middle High German language and literature; selective readings from representative literary works of the period. P, 302b, 315b. Classen

520. History of the German Language (3) II 1989-90 Introduction to Germanic philology; an overview of the development of the German language from its roots in the Indo-European languages to Middle and High German. P, 8 units of upper-division German. (Identical with Eng1. 520) Classen

525. Beowulf (3) II (Identical with Engl. 525)

527a. Studies in Medieval Language and Literature (3) (Identical with Engl. 527a)

555. *Music and German Literature (3) I 1990-91 The interrelationship between music and literature of the 18th century. Concentrates on major works of German drama, poetry and prose, and their musical settings. Lectures in English. Readings primarily in German. P, 202. (Identical with Mus. 555)

575a-575b.* Advanced Grammar and Stylistics (3-3) CDT Pracitcal training in written German thought. Provides in the more complex refinements of German grammar and style, as found in representative documents. P, 315b. 575a is not prerequisite to 575b. Richter

575b.* Language Teaching (3) I Modern methods of language teaching with emphasis on German as a foreign language. Schulz/Wilden-Bassett

580.* Applied Linguistics for Foreign Language Teaching (3) II 1990-91 Issues in and methods of applied linguistics with emphasis on Germanic languages. Schulz/Wilden-Bassett

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II Application of computers to literary style, authorship, vocabulary measures, indexes and concordances, metrics and versification. P, 3 units of literature at the 300 level or above. (Identical with Engl. 585, Fre. 585, Clas. 585, Ling. 585, Russ. 585, and Span. 585)

*May be convened with 400-level course.

594. Practicum
a. Translation (2-5) [Rpt./3] P, 496a or departmental proficiency exam.

596. Seminar
a. Translation (3) [Rpt./3] I II P, competency at third-year undergraduate level or pass departmental placement test.

601. Materials and Methods of Research (3) I Survey of the tools and methods of literary and linguistic research and introduction to principles of literary analysis. Chisholm/Classen

896. Seminar
a. Linguistics (2-4) [Rpt./II] P, 696b
b. Folklore (2-4) I II (Identical with Engl. 696c)

c. Pedagogy (2-4) [Rpt./II] P, 696d

tenure track position. The College of Liberal Arts and Sciences offers a Bachelor's degree in German that can be completed in 3 to 4 years. A minor in German is also available. For more information, please visit the German Department website or consult with a faculty member.

Gerontology (GERO)

Anthropology Building, Room 214
(602) 621-4086

Committee on Gerontology (Graduate)

Professors William A. Stini (Anthropology), Chairperson, Daniel R. Boone (Emeritus, Speech and Hearing Sciences), John T. Boyer (Internal Medicine), Herbert E. Car (Biochemistry), Theodore A. H. Koff (Management and Policy), Fred B. Roby, Jr. (Exeter and Sport Science), Roy G. Specke, Jr. (Mathematics), Charles W. Weber (Nutrition and Food Science), and Mary L. Thompson (Healthcare Administration). Associate Professors Alfred W. Kasznicki (Psychology), Douglas J. McAdam (Sociology), Jessie V. Perginz (Nursing), Pamela G. Re (Gerontology), Stella Mae Smith (Special Education and Rehabilitation).

Assistant Professor Evan W. Kligman (Fam and Community Medicine)

Because of its multidisciplinary nature, study of gerontology is located in a number of departments. The Committee on Gerontology plays a facilitating role in the coordination and development of aging studies and will guide study of gerontology is located in a number of departments. The Committee on Gerontology plays a facilitating role in the coordination and development of aging studies and will guide students interested in incorporating a gerontological emphasis into their chosen field. Although the graduate major is offered, the Committee offers a doctoral minor appropriate for students in areas such as education, administration, health, nutrition, and the social and behavioral sciences. A minimum of fifteen units selected from at least fifteen units of course work is required in order to be considered for graduation. It is also possible for students to pursue a gerontological study in the Gerontology Certifcat Program which offers formal recognition to those who have completed an eighteen-unit structured course in aging. The program is similar to that in many other colleges and universities in the country and is designed primarily for individual planning to enter into a profession which involves provision of services and administration of programs for the aging.

Students should consult with the major department about their development of a gerontological emphasis within the major field through coursework, research, thesis, and dissertation. The most common occurs in the departments of Management and Policy, Psychology, Speech and Hearing Sciences, the Division of Speech and Hearing Sciences, the School of Family and Consumer Resources, the College of Nursing and Pharmacy. In addition, graduate work with a strong gerontological focus is available in human services administration (M.P.A.), and gerontological nurse (M.S.). Courses in other departments identified as having content which deals specifically with elderly and aging processes include: Cuc. 570; I.O. 406; Psy. 521 and 528; M.A.P. 45, 595d, 662.

Further information on gerontology study and Committee programs can be obtained from the coordinator of the program at the address above.

506.* Social Gerontology (3) II (Identical with Soc. 506)

535. *Psychological Problems of the Aging (3) (I) (Identical with Psych. 535)

536. *Economics of Aging (3) (I) (Identical with C.S. 536)

538. *Problems in the Biochemistry of Aging (2) (90-91) (Identical with N.F.S. 538)

545. *Clothing for Special Needs (3) (I) (Identical with C.T. 545)

547. *Perspectives in Geriatrics Laboratory (1) II (Identical with Ph.Pr. 547)

548. *Perspectives in Geriatrics (2) (I) (Identical with Ph.Pr. 548)

557.* Biology of the Elderly (2) II (Identical with M.P. 557)

570a.* Human Adaptability (3) I (Identical with Anth. 570a)

*May be convened with 400-level course.

576. Communicative Aspects of Aging (3-5) I (Identical with Sp.H. 576)

589. Health of the Old Adult (3) I (Identical with Nura. 589)

*May be convened with 400-level course.
Health-Related Professions

School of Health-Related Professions

The School of Health-Related Professions offers programs leading to the Master of Arts and Master of Science degrees in a variety of health-related fields. These programs are designed to prepare individuals for careers in the health sciences, as well as to provide education for those interested in various functional areas involved in the conduct of health programs.

Hygiene and Safety (OSH)

0.* Physical Exposures (3) II Recognition, evaluation, and control of physical exposures, including radiation, noise, vibration, and heat stresses. P, 486 (Identical with C.E. 586, M.R. 486).


2.* Advanced Ind. Hygiene and Safety (3) Comprehensive coverage of the industrial hygiene and safety professions emphasizing the principles of contaminant generation and the design of industrial hygiene/safety programs. P, 486. (Identical with C.E. 589, Tox. 587).

Exercise and Sport Sciences (EXSS)

Study programs for both the Master of Arts and Master of Science degrees are individually designed, in consultation with the student, to provide a firm basis in the student's area of interest. Concentrations are available in athletic training, biomechanics, exercise physiology, motor behavior, sports administration, and sport psychology. Students must complete a minimum of 30 units and prepare a thesis for which 6 units are required. P, 530.

Psychological Interventions and Ergogenic Aids for Peak Performance (3) Designed to provide a theoretical framework for students pursuing sports management careers and others interested in various functional areas involved in the conduct of sport programs.

Exercise EKG Interpretation and Cardiac Medications (1) Normal and pathological functioning of the heart during rest and exercise, EKG interpretations, drug treatment for cardiac dysfunctions, and stress testing principles. P, 530.

Nutrition in Exercise and Sport (3) I.S.A critical analysis of research in the role of nutrition in physical performance. Emphasis on both nutritional deficiencies and supplements and their relationship to performance, the assessment of nutritional status, the interaction of exercise and nutrition in fitness and weight control programs. P, 360 or 370, Ecol. 159a-159b, 160a-160b. Atwater/Enoka.

Principles of Nutrition (3) I Designed to provide a theoretical framework for populations with chronic diseases as it relates to performance and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams.

Physical Activity in Aging and Chronic Disease: Physiological Aspects (3) I Designed to provide a theoretical framework for populations with chronic diseases as it relates to performance and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams.

Biomechanics of Human Movement (3) I Designed to provide a theoretical framework for students pursuing sports management careers and others interested in various functional areas involved in the conduct of sport programs.

Exercise EKG Interpretation and Cardiac Medications (1) Normal and pathological functioning of the heart during rest and exercise, EKG interpretations, drug treatment for cardiac dysfunctions, and stress testing principles. P, 530.

Nutrition in Exercise and Sport (3) I.S.A critical analysis of research in the role of nutrition in physical performance. Emphasis on both nutritional deficiencies and supplements and their relationship to performance, the assessment of nutritional status, the interaction of exercise and nutrition in fitness and weight control programs. P, 360 or 370, Ecol. 159a-159b, 160a-160b. Atwater/Enoka.

Physical Activity in Aging and Chronic Disease: Physiological Aspects (3) I Designed to provide a theoretical framework for populations with chronic diseases as it relates to performance and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams.
594. Practicum (1) II Laboratory experience in the field of recreation and participation in a research project. CR 570. Lohman

579. Statistical Analysis in Exercise and Sport Sciences (3) I Analysis of research designs and data analysis procedures in the field of exercise and sport sciences with emphasis on the appropriateness of selected descriptive and interpretative procedures of various data analysis procedures. Statistical power, reliability, covariance and multiple regression techniques and uses of micro- and mainframe data analysis software. P. 570 and 571. Lohman

580. Evaluation of Athletic Injuries (3) I Advanced study of the etiology, pathology, and clinical signs of common athletic injuries. Emphasis on the development of a research hypothesis by the athletic trainer. P. 377; 800 hours of clinical experience in athletic training. Delforge

581. Physical Modalities (2) II Advanced study of the role of hydrotherapeutic and electrotherapeutic agents in the rehabilitation of athletic injuries. P. 580. Delforge

582. Clinical Analysis of Sport Injuries (3) I Comprehensive survey of bones, ligaments, muscles, nerves, and vessels of the trunk and upper and lower extremities, with emphasis on their relationship to sport injuries. 2R, 3L. P. CR 580. Hillman


584. Rehabilitation of Athletic Injuries (3) I Principles in the planning and implementation of rehabilitation programs for injured athletes with emphasis on application of contemporary therapeutic exercise techniques. P. 580. Delforge

585. Issues in Athletic Training and Sports Medicine (3) I Current issues and trends in the athletic training and sports medicine with emphasis on the professional preparation of athletic trainers and the role of the certified athletic trainer in athletic health care delivery systems. P. 580. Delforge

586. Physical Education and the Law (3) I Investigation and analysis of legal parameters within which the physical educator must operate; negligence theory; common defenses; product liability; insurance; legal implications for program development and methodology. Baker

587. Legal Aspects of Sports Administration (3) II Development of administrative and coaching techniques from the legal perspective. Analysis of personnel procedures, purchase of equipment, athletic associations, certification, transportation, medical procedures, officiating, and the handicapped athlete as influenced by litigation. P. 586. Baker

591. Preceptorship (1) I II S 1R, 3L. P. 580, 594b, CR certification.

593. Internship (1) I II S 1R, 3L. P. 530, 594b

594. Practicum (1) I II S 1R, 3L. P. 528 or 529.

595. Colloquium (1) I II S 1R, 3L. P. 370 or 460.

596. Seminar (1) I II S 1R, 3L. P. 464a-464b; An. 467R.

599. Analysis of Data in Exercise and Sport Sciences (1) I II Atwater

*May be conformed with 400-level course.

605. Colloquium (1) I II S 1R, 3L. P. 464a-464b; An. 467R.


Medical Technology (MEDT) 1435 N. Fremont Ave., Room 106 (602) 626-6620

Associate Professor B. Sue Criswell, Director
Assistant Professors Jae O. Kang, Harold L. Potter, Jr., JoAnn Thomas

Consult the Division of Medical Technology for information on graduate courses.

Hebrew (See Oriental Studies)

Higher Education (See Education)

Hindu (See Oriental Studies)

History (HIST)

Social Sciences Building, Room 215 (602) 621-1586

Professors Michael Schaller, Head, Herman Bateman (Emeritus), Gail Bernstein, Robert P. Browder (Emeritus), Paul A. Carter, Richard Cosgrove, Leonard Dinnerstein, James Donohoe (Emeritus), Robert M. Gimello (Oriental Studies), Harwood Hinton, Ursula Lamb (Emeritus), John V. Merlin, Michael C. Meyer, Roger L. Nichols, Heiko A. Oberman, J. Gregory Oswald (Emeritus), Thomas W. Parker (Emeritus), Boyd Shafie (Emeritus), Jing-then Tao (Oriental Studies), Robert Vignery, Donald Weinstein


The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in History. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in History.

Applicants for the graduate program must have completed the equivalent of the bachelor’s degree in a major of history or related subject and are required to submit scores on the aptitude tests of the Graduate Record Examination, a statement of purpose, and three letters of recommendation. Unless a master’s degree is earned at the University of Arizona, students must 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 21 units of electives. Not less than six of which are at the 595 level or above. An oral or written examination covering the work in history as well as an examination by the college of Education must be passed. Thesis is required.

Master of Education: All students must complete at least eighteen units in history, not less than six of which are at the 595 level or above. An oral or written examination covering the work in history as well as an examination by the college of Education must be passed. Thesis is required.

Doctor of Philosophy: In consultation with a major advisor, each beginning student will select a major and minor field of study. Each student must demonstrate a reading knowledge of one foreign language, and possibly other skills will be required. An oral or written examination covering the fields chosen. Following this examination, the candidate must prepare and defend a dissertation displaying mature research in origin sources, competence in assembling and presenting historical data, and critical scholarship.

Major Fields: Ancient History; Europe, since 1648; Latin America; United States. Minor Fields: Any major or other than chosen major; an approved minor another department; or Asian History; Artistic Theory in Museum Studies or Historical Preservation; Comparative Women's History; History of Religion.

501. History of Modern Europe (3) I See Art History (501)

603. Medieval England (3) I From the Norman Conquest to the Hundred Years War, w emphasis on political, social, and cultural developments.

507. Historical Methodology of Medieval Europe (3) I Major medieval cultural and intellectual trends including the interplay of the Greco Roman, Christian, and Arabic traditions.

508. The Reformation (3) I See Reformation (508)

610. History of Early Europe (3) I History of Europe from the death of the Roman World to the 15th century. 610 is not prerequisite to 610b.

506. Medieval Europe (3) I From the Norman conquest to the Hundred Years War, w emphasis on political, social, and cultural developments.

510. History of Hell in Early Europe (3) I History of the concept of hell in Western Europe from the Bible to Dante. Includes the Hebrew, Greco-Roman, Germanic, and Christian traditions.

514. Medieval and Early Modern Germany (3) I See German History (514)
History of science deals with the origins and development of science as an activity which seeks understanding of our universe. Philoso-
phy 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 Department 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 aspects, as well as to students of philosophy or history.

Home Economics
(See Family and Consumer Resources)

Hydrology and Water Resources (HYDR/WRA)

Geology Building, Room 122
(802) 621-5082

Professors Daniel D. Evans, Acting Head, Nathan Buras, Donald R. Davis, Stanley N. Davidson, Charles J. Deach, John A. Hershberger, William L. Lord, Ernest T. Smerdon (Civil Engineering), John W. Harshbarger (Emeritus), Richard H. Hawkins (Watershed Management), Simon Ince (Civil Engineering), James R. Long (Geosciences), and Harshbarger (Emeritus), Richard H. Hawkins (Watershed Management), Simon Ince (Civil Engineering), James R. Long (Geosciences), and Shlomo P. Neuman, Eugene S. Simpson (Emeritus), Ernest T. Smerdon (Civil Engineering), and Shlomo P. Neuman, Eugene S. Simpson (Emeritus), Ernest T. Smerdon (Civil Engineering), and Soroosh Sorooshian

Associate Professors Randy L. Bassett, Michael D. Bradley, Assistant Professors Roger C. Bales, T.C.-Jim Yeh

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, hydrochemistry, 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 grad-
uates from the basic sciences and from related fields such as geology, engineering, agriculture, meteorology, economics, and political sci-
tence to enter directly. Applicants should submit Graduate Record Examination scores (general test only) and three letters of recommendation. Graduate study programs are individually planned to meet the student's special interests and professional objectives. Certain basic courses in hydrology and water resources are required and the program'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 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 hydro-

Water Resources Administration: The Master of Science and the Doctor of Philosophy degrees are offered with major in water resources administration. This interdisciplinary program is for students with special interests in operations research, management, or the social sciences as related to water resources. Students major in the program are expected to have or acquire a basic knowledge in hydrology. Three areas of concentration are currently defined: water policy and planning, water resources systems, and water quality management.

Hydrology (HYDR)

502. Snow Hydrology (2) I 1990-91 (Identical with Ws. M. 502)

503. Subsurface Fluid Dynamics (3) I Kinematics and dynamics of fluids in saturated porous and fracture media; introduction to free surface, unsaturated, and multiphase flows. P, A.M.E. 331a or C.E. 321, Math. 422a. (Identical with Geos. 535)


506. Water Quality Dynamics (3) II Chemical and physical methods used to study the quality of ground and surface waters with emphasis on analytical methods, hydrogeochemistry, heterogeneous processes, colloids, and surface processes including sorption phenomena. Equilibrium and dynamic models of water chemistry. P, Chem. 480a or 450.

507.* Hydrology of Unsaturated Media (3) Physical properties and processes of unsaturated media related to storage and movement of water and transport of contaminants. (Identical with S.W. 507)

508.* Vadose Zone Monitoring (2) I Laboratory and field methods for characterizing water flow and contaminant transport through unsaturated geologic media. 6L. P, 407 or 507, 518.

514a-514b.* Field Hydrology (Summer Camp) (3-3) S Field methods of collection, processing, and interpretation of data in surface and groundwater hydrology; investigation of a small water resources project; preparation of hydrologic reports. Daily field work. Fee. P, 407 or 507, 423/523, 431/531, 519.


517. Fundamentals of Water Quality (3) I Introduction to chemical processes affecting the behavior of major and minor chemical species in the aquatic environment. Physical, equilibrium, organic, and analytical principles as applied to natural waters. 2R, 3L. Open to majors only. P, Chem. 103b, Phys. 103b, and Math. 125b.

518. Subsurface Hydrology (3) I Physical, chemical, mathematical, and geometric principles for understanding hydrologic processes. Open to majors only. P, A.M.E. 331a or C.E. 321; Math. 125b; Geos. 101a.


522. Well Logging Interpretation (3) II (Identical with G.En. 522)

523.* Hydrology (3) I (Identical with CE 5)

531.* Hydrogeology (3) I (Identical with Geos. 531)Geologic and hydrologic factors controlling occurrence and development of ground water. 2R, 3L. Field trips.


536. Development of Ground-Water Resources (3) II Analytic techniques to evaluate geohydrologic systems; case histories used for study management of ground- and surface water resources; planning and design of regional water resource investigations. 4R, 5L. P, 535. (Identical with Geos. 536)

540. Advanced Surface Water Hydrology (3) I Fluvial dynamics and flooding; historical development and application of mathematical models to river and flood routing; flood hydrology; hydrology of water supply, drainage, and numerical methods. P, 423 or 523.

545.* Statistical Hydrology (3) I II Application of mathematical and statistical techniques to estimation of uncertainty in the design, measurement, and manipulation of hydrologic processes, and in the design of water resources development projects. P, S.I.E. 170, 180.

550.* Environmental Hydrology (3) II Chemistry of surface and subsurface water; the dominant chemical processes affecting groundwater composition in relation to major ionic and organic contaminant; introduction to chemical techniques; chemical and numerical methods for subsurface fluid flow and contaminant transport. P, 3R, 4L. P, Chem. 103a-103b, S.I.E. 170.

557.* Low Temperature Geochemistry (3) (Identical with Geos. 557)

560.* Watershed Hydrology (3) (Identical with Geos. 563)

563. Isotope Hydrology (3) (Identical with Geos. 563)

571.* Water Quality Control (3) II (Identical with C.E. 571)

580.* Hydrologic Systems (3) I Introduction to average and flow transporting, emphasis on model construction and simulation. 2R, 3L.


596. Seminar
k. Risk and Society (3) [Rpt./6 units] (Identical with Anth. 596k, Geog. 596k, in Jour. 596k)

p. Hydrogeology (1-3) [Rpt./2.] II (Identical with Geos. 596p)

603. Well Hydraulics and Pumping Tests Analysis (2) I 1990-91 Flow to wells in aquifer with emphasis on design and interpretation; pumping tests; confined, unconfined, and leaky aquifer systems; fractured rocks; automatic curve matching. P, 503 or 535, Math. 422a.

605. Soil Water Dynamics (3) I II 1990-91 (Identical with S.W. 605)


645. Stochastic Methods in Subsurface Hydrology (3) II 1989-90 Application of the frst order stochastic processes and random field theory to natural variability in subsurface hydrology. 4R or Stat. 361.

655. Advanced Statistical Hydrology (3) Advanced application of statistics and prob

98 Departments and Courses of Instruction
to hydrology and water resources; multiple modeling, choice of models and parameter estimation, Bayesian decision theory. P, x 519 or 545 or Stat. 361.

Colloquium (1-3) [Rpt./j] II Seminar
Unsaturated Flow (2-3) II Regional Hydrologic Analysis (1-3) II P, 423, 431
Desert Hydrology (1-3) [Rpt./2] II 1990-91
Pollutants in the Hydrologic Environment (1-3) II Advanced Hydrologic Modeling (1-3) II P, 642 or consult department prior to enrollment.

Aquatic Chemistry of Surfaces (1-3) I 1989-90 P, 506.

Water Resources Administration (WRA)
5. 501b. Water Resources Management (3-3) Institutional and policy aspects of water resources administration; management, organizational theory, and inter- nal problems of water use and development; ground-water management and policy. P, is not prerequisite to 501b.


5. Water Resources Management, Plan, and Rights: A Policy Approach (3) II An introduction to basic concepts and issues of water resources management and administration, emphasizing water law and rights, water sources planning, institutional and organizational arrangements, and policy processes such as adjudication and rule-making. Open to seniors only.

5. Water Quality Modeling (3) I (Identical with C.E. 525)

5. Water Quality Management (3) II Optimization and systems analysis techniques used in modeling; current models used in formulation of water quality policy. P, S, 5. (Identical with C.E. 526)


5. Ground-Water Management (3) II Management techniques for regional aquifer systems. Quantitative methods for both quantity and quality aspects of ground-water management. P, 444 or 544. (Identical with C.E. 560)

576. Advanced Natural Resource Economics (3) I (Identical with A.Ec. 576)

577. Natural Resource Economics and Public Policy (3) II (Identical with A.Ec. 577)

580. Forest Policy and Administration (3) II (Identical with Ws.M. 580)

581. Environmental Policy (3) II (Identical with Pol. 581)

May be convened with 400-level course.

643. Water Resources Systems Analysis (3) I (3) 1990-91 Applications of mathematical programming to the analysis of interactions of hydrology, engineering, economics, and socio-institutional environmental impacts in regional water resources systems. P, 544 or consult department before enrolling.

695. Colloquium
b. Water Resources Administration (1-3) [Rpt./1] II
696. Seminar
h. Long-Range Resource Planning (1-3) [Rpt./2]
 i. International Water Resource Management (1-3) [Rpt./2]
 j. Water Quality Planning and Policy (1-2) II
 m. Water Storage Systems (1-3) [Rpt./1] II P, consult department before enrolling.

Industrial Engineering
(See Systems and Industrial Engineering)

Interdisciplinary Programs (IDIS)
PAS Building, Room 238
(602) 621-6616

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. A number of graduate degree programs are administered by committees (see catalog for membership and program details).

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 Plng. 596u)

Interior Design
(See Family and Consumer Resources)

Irrigation
(See Agricultural Engineering)

Italian
(See French and Italian)

Japanese
(See Oriental Studies)

Journalism (JOUR)
Franklin Building, Room 101M
(602) 621-5040

Professors George W. Ridge, Jr., Head, Donald W. Carson, Abraham S. Chain, Philip Mangelsdorf

Associate Professors Ford N. Burkhart, William F. Greer, James W. Johnson, Jimmy D. Patten, Jacqueline E. Sharkey.

The department offers a program leading to the Master of Arts degree with a major in journalism. The program is designed for students dedicated to developing or improving professional skills while attaining an academic background in one or more specializations.

An undergraduate major in journalism is not necessary for admission. Students are required to complete 205, 206, and 320 as deficiencies without graduate credit.

A minor from these units is required for the master's degree. Electives are chosen from journalism or related fields with the approval of the advisor. A complete program of study must be approved by the graduate advisor in the first semester, and the advisor must approve any subsequent changes. No foreign language proficiency is required, although for those interested in Latin America, the department has an exchange program in Guadalajara.

Students are required to work on two departmental newspapers and to demonstrate a high level of skill in reporting and writing courses. The program of study must include 502, 509, 511, 513, 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.

502. Freedom of Expression (3) II Analysis of access and barriers to information and communication at local, state, national and international levels; intensive study of the legal relationship between mass media and society.

Open to majors only.

503. Advanced Photojournalism (3) II Reporting and interpreting the news through photos, photo documentaries, and photo analysis. Open to majors only. P, 301, 302.

505. The Study of News (3) II Critical study and problem analysis of the media. Field work may include publication of conclusions.

509. Media in the Twentieth Century (3) I The social, cultural, and economic role of the mass media in American society. Interaction of press and government at judicial, executive, and legislative levels.

510. News Features (3) I Writing the basic news feature article; specialized reporting and rewriting techniques. P, 206.


513. Reporting Public Affairs (3) II Study and practice of newspapering on executive, legislative, and judicial levels in city, county, state and federal governments, with emphasis on news sources and interpretive writing. P, 206.

514. The News Agency: Arizona News Service (1) [Rpt.] II The 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 412.

515. The Editorial Page (3) I 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.

516. The Weekly Newspaper (3) I Community and suburban weeklies, including problems of news coverage, production, advertising and circulation. Integration of electronic text systems. Field trips.
Landscape Architecture
(See Renewable Natural Resources)

Latin
(See Classics)

Latin American Studies (LAS)
Social Sciences Building, Room 216
(602) 621-1137

Latin American Area Center
Director Michael C. Meyer
Assistant Director Raúl P. Saba

Professors Michael C. Meyer (History), Donald W. Carson (Journalism), Roger Fox (Agricultural Economics), Lainin A. Gyurko (Spanish and Portuguese), Boris S. Kozolchik (Law), Edward J. Williams (Political Science)

Associate Professor Celestino Fernández (Sociology)
Assistant Professor Raúl P. Saba

The Latin American Area Center offers an interdisciplinary program leading to the Master of Arts degree with a major in Latin American studies. Programs are designed primarily for students planning government, business, teaching, or related careers. The Center assists its students in career development by providing counseling and information relating to internships and careers.

Applicants should indicate the intended area of concentration. A faculty member from the proposed area of concentration will evaluate the transcripts to determine whether there will be undergraduate deficiencies to be satisfied without graduate credit. Scores on the aptitude test of the Graduate Record Examination are strongly recommended.

The master's program consists of 35 graduate units, with an area of concentration and two related areas. Minimum unit requirements are fifteen (including one research seminar) for the concentration and six and six for the two 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 Latin American Studies, Spanish and Portuguese, sociology, and economics. As English as a second language, educational foundations and administration, family and consumer resources, geography and regional development, political science, history, journalism, law, library science, nursing, pharmacy, Portuguese, sociology, and Spanish.

Neither of these supporting fields may duplicate the area 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. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. Proficiency may be established by completion of Port. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. The student and the advisor will determine which language should be emphasized. All students 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.

595. * Colloquium
a. Latin American Studies (3) [Rpt.] II P. Spanish or Portuguese proficiency.

*May be convened with 400-level course.

596. Seminar
a. Latin American Studies (3) [Rpt.] I P. Spanish or Portuguese proficiency.

*May be convened with 400-level course.

100 Departments and Courses of Instruction


506. Research Methods (3) I II Need and opportunities for research in librarianship; types of research; research methodology; study of research design; elementary statistics.

507. Library Management (3) I II Introduction to management concepts, the organizational structure of libraries, systems analysis, financial administration and the utilization of library personnel.

509. Information Sources for Agricultural Scientists (1) I (Identical with P.S. 509)

510. Introduction to Information Science (3) Methods, theories and applications of the field of information science; elements of computer programming and systems design; implementation and management of computer systems in libraries and information centers.

511. Information Storage and Retrieval (3) Student involvement in on-line, interactive systems.

512. Automation in Libraries (3) I II Introduction to automated procedures currently in use in libraries, including systems analysis of actual technical services and planning for their automation.

513. Library Systems Analysis (3) I Introduction to quantitative methods for the design, analysis and control of library systems.

515. Library Cooperation and Networks (3) Study of the growth and state of the art of library cooperative systems, networks, and bibliographic utilities.

517. Preparation of Instructional Materials (3) II (Identical with T.E. 517)

519. Cartographic Information Management (3) I Cartographic format as an information transfer medium. History of cartography and problems in interpretation of cartographic products. Role and place of maps in the information environment.

521. Advanced Cataloging (3) II Comparative study of Dewey Decimal Classification and Library of Congress Classification; advanced problems in descriptive cataloging, subject headings, and library filing.

526. Introduction to Bibliography (3) Introduction and critical examination of various styles of bibliographic description; practical application in construction of a systematic bibliography.

530. Public Librarianship (3) I Administration to include supervisory; preparation serving the general public, including problems of governmental relationships, community responsibilities, financial support, buildings, personnel, collections.

540. Academic Librarianship (3) I Introduction to the role of the academic librarian in the campus environment. Emphasis on development of relevant skills. Open to majors only.

541.* Children's Literature in Spanish (3) I (Identical with Span. 541)

542.* Mexican-American Literature (3) II (Identical with Span. 543)

546. School Library Administration and Organization (3) II Services, finances, personnel, evaluation, quarters, organization and technical services in the school library.

550. Special Librarianship (3) I II Mission, organization and administration of the special library.

560. History of Books and Printing (3) I Survey of the history of books and printing from earliest 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 II Survey of literature for children in England and America from earliest times to the close of the 19th century, together with study of cultural and social values reflected in the literature. (Identical with Engl. 561)

562. Library Public Relations and Communication (3) I I Essentials for library public information activities, brochures, news releases and public service announcements for radio and television, communication problems at public service desks.

570. Literature of Science and Technology (3) I Creation, organization, and dissemination of scientific and technical literature; reference function and problems of bibliographic control. A science background is not required.

571. Information Sources in the Social Sciences and Humanities (3) I II Survey of bibliographic and reference sources in the humanities and social sciences, with emphasis on the structure of knowledge in the various disciplines and evaluation of user services.

573. Government Publications (3) I II Examination of the varieties of government publications available from municipal, county, state, national and international agencies, with emphasis on selection and use of publications of the U.S. Government.


576. Administration of Reference (2) I Theory of information service, policy development, special services, and administration of reference services.


581. School Library Administration and Organization (3) II Services, finances, personnel, evaluation, quarters, organization and technical services in the school library.

582. Audiovisual Materials in Libraries (2) I Introduction to AV information resources for the library.

584. Literature for Adolescents (3) 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.

586. Oral Presentation of Children's Literature (2) I Principles and techniques of storytelling and of reading aloud to children; stories for different age groups, preparation of stories; practice in reading and telling stories and in planning the story hour.

589. Scholarly Communication (3) II Structural and environmental aspects of scholarly communication and products in the U.S. Examines the content and technology of scholarly communication in various disciplines. (Identical with Comm. 589)

600. Introduction to Graduate Study in Music (3) I II (Identical with Mus. 600)

607. Planning Library Services (3) I The total planning cycle as a management approach to various library/information center services. Open to majors only.


615. Scientometrics and Bibliometrics (3) I Study of quantitative techniques for measuring scientific and technical literature. Covers history and theory as well as current techniques. Emphasis on current research and developments.

620. National and International Information Policy (3) I Investigates the formulation and implementation of those laws and policies that govern the flow of scientific and technical information in the United States and between the United States and selected countries.

693. Internship I (1-3 credits) May be repeated for a maximum of 6 credits.

"*May be repeated for a maximum of 6 credits."

Library Science (LIS)

15 East First Street
302-3565

July 1989/90

Graduate Library School

Books and Journals

A. Academic Library (2-4) [Rpt./1] I I II S P. 502, 503, 504, 505, CR 507 or CR 540
504. Foundations of Syntactic Theory II (3) II Continuation of Ling. 503, with emphasis on recent literature.

505. Extended Categorial Grammar (3) I An introduction to categorial grammars and their extension to extend the expressiveness of the language, addressing the representational and computational aspects of the language, including the functional composition of type-changing rules, application to natural language structures.

510. *Foundations of Phonological Theory I (3) I Investigation of the principles that underlie current phonological theory, concentrating on the representational and computational aspects of the language, including the functional composition of type-changing rules, application to natural language structures.

511a-511b.* Modern Japanese Grammar (3-3) (Identical with Or.S. 511a-511b)

514. *Foundations of Syntactic Theory II (3) I An examination of the evidence and arguments for non-linear representations (autosegmental and metrical), and the organization of the phonological component of grammar, including evidence for its interaction with morphological structures and rules.

515. Phonology and Phonetics (3) I Analysis of the phonetic and articulatory properties of sounds and patterns of sounds that occur in human language. Emphasis on the significance of the properties of sounds for phonological theory, in particular, distinctive feature theory. Role of psycho-acoustic studies as a source of evidence for phonological theory.

520a-520b.* Linguistic Structure of Modern Chinese (3-3) (Identical with Or.S. 520a-520b)

522.* Linguistic Semantics and Lexicology (3) II 1990-91 Study of word and sentence meanings, relationships between the lexicon and the grammar, idioms, metaphor, etymology, and change of meaning. (Identical with Phil. 522)

523a-523b.* Theory of Spanish Syntax (3-3) II (Identical with Span. 523a-523b)

526.* Introduction to Arabic Linguistics (3) II (Identical with Or.S. 526)

527.* Applied Linguistics (3) I (Identical with Span. 527)

540. Language Change and Reconstruction (3) II 1990-91 Introduction to the methods in, theory of, and problems of historical linguistics, including language change and reconstruction. Data will be drawn from a variety of the world’s language families, but will concentrate on American Indian languages and languages of the written record.

544. Syntactic Analysis (3) I An examination of the syntactic diversity presented by natural human languages, and the reconstruction of the issues that such diversity presents for syntactic analysis. Topics include AUX, word order, constituent, and subjects.

551. Language Acquisition (3) II (Identical with Sp.H. 551)

556.* Linguistics and the Study of Literature (3) II 1990-91 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 Cp.Lt. 556)

564. *Formal Semantics (3) I (Identical with Phil. 564)

565.* Pragmatics (3) I 1989-90 Study of language use, its relationship to language structure and context; topics such as speech acts, presupposition, implication, performatives, conversations. (Identical with Phil. 565)

573.* Natural Language Processing (3) I 1989-90 Introduction to processes underlying speech production and comprehension: speech sounds, words, parsing, semantics and pragmatics. (Identical with Phil. 573, Psy. 573)

578.* Language in Culture (3) I (Identical with Anth. 576)
ship, access to services and ethics. Focuses upon the recognition and analysis of legal problems and identification of legal resources. (Identical with Gero. 557)

560. Trends in Management Theory (3) I Review of management practices from the Industrial Revolution to modern high technology organizations. Focus on contemporary organizational issues and managerial responses to them. P. 505 to 500. (Identical with Ping. 560a)

562. Design and Control of Production Systems (3) II (Identical with M.I.S. 567)

566. Environmental Scanning (3) I (Identical with Mktg. 566)

571. Business Strategy and Policy Making (3) II Case method approach to problems and policies facing top management in making and effecting a strategic plan. P. 500, 502. Fin. 511, 5ktg. 500. To be taken in the final semester of the M.B.A. program. Open only to students admitted to a B.P.A. graduate program. An open to M.B.A. integration students admitted to B.P.A. graduate programs.

575. Housing and Residential Areas (3) I Physical, social, and economic aspects of housing development and residential areas and their relationships to their uses and functions. (Identical with Ping. 575)

580a-580b. Theory of Management and Organizational Behavior II Fundamentals of the behavioral regulation 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. 503 or 502; 580a is not prerequisite to 580b.

595. Colloquium
   a. Local Government Administration (3) [Rpt./12 units] II
   c. Health Care (3) [Rpt./12 units] II
   d. Aging and Society (3) [Rpt./12 units] II
   f. Criminal Justice (3) [Rpt./12 units] II

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. Emphasis on formulation of research questions and alternative research strategies for answering them.

601. Public Management (3) I Fundamentals of management structure and process in public sector: emphasis on professional practice. Open only to students admitted to a B.P.A. graduate program.

602. Analytic Methods in Planning and Management (3) II Methods and models for program planning and policy analysis; forecasting, service demand, facility location in capital investment programming, task sequencing, program analysis and evaluation. P. 457 or M.I.S. 552. (Identical with Ping. 602)

605. Research and Evaluation in Public Administration (3) I Research and evaluative methodologies which support public sector policies and administration, including the philosophical basis of these methods and a research design exercise. P. 601, M.I.S. 552.

609. Policy Problems in Structure and Change (3) II Problems presented by structure and change in modern urban society from the standpoint of social systems analysis; evaluation of degree of public policy and planning. (Identical with Geog. 609 and Ping. 609)

610a-610b. Fiscal and Budgetary Administration of Public Organizations (3-6) I- II 610a: Internal financial operations and the budgetary cycle of public and nonprofit agencies. P. 601, 5ct. 572. 610b: Cost/benefit analysis for public agencies.

610a is not prerequisite to 610b. (Identical with Pol. 610a-610b)

612a-612b. Projects in Policy and Planning (2-3) Lab. and field projects simulating various aspects of professional practice. Open only to majors only. P. 12 units toward M.S. (Identical with Ping. 612a-612b)

621. Administrative Patterns in the Federal System (3) I Legal, political, and social framework of interjurisdictional and interagency relations; trends, emerging issues, and devices for securing coordination and responsibility.

650. Administration of Health Systems (3) I Introduces the student to the scope and nature of public and private health systems in the U.S.; examines roles of government and private enterprise in the development and operation of health institutions. P. 601.

651. Health and Public Policy (3) I Examines public policy issues in health, including recent developments in health policy and planning at the national, state and local levels, and their impact on administrative behavior. P. 650. (Identical with Ping. 651)

652. Management of Long Term Care Facilities and Programs (3) II Problems and principles of management of facilities and community based programs providing health and social services to the chronically ill. P. 500 or 502.

653. 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.

655. 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. 500. (Identical with Ping. 655)

662. Aging and Public Policy (3) I Policy framework for administration of programs, plans, priorities, and legislation related to the needs of the aging in modern society. (Identical with Ping. 662)

671. Business, Government and Society (3) I II Relationships between the institutions of business and government; economic, social and political aspects. P. 505 or 502. (Identical with Law. 671)

693. Internship
   a. Criminal Justice (1-6) I
   c. Public Management (1-6) I
   d. Criminal Justice (1-6) I
   f. Long Term Care Administration (1-6) II
   g. Policy and Planning (1-4) I

696. Seminar
   a. Development Administration (1-3) I
   b. Program Planning and Development (1-3) I
   c. Performance Measurement and Accountability (1-3) I
   d. Health Services Administration (1-3) I
   g. Criminal Justice Administration (1-3) I
   h. Land-Use Regulation (3) I (Identical with Ping. 696h)
   i. Legal Inquiry in Policy and Planning (3) I
   j. Environmental Regulation (3) I (Identical with Ping. 696j)
   k. Planning Administration (3) I (Identical with Ping. 696k)
   l. Organizational Behavior (3) [Rpt./6 units] II

699g. Seminar
   a. Development Administration (1-3) II
   b. Program Planning and Development (1-3) II
   c. Development Administration (1-3) II
   d. Program Planning and Development (1-3) II
   e. Development Administration (1-3) II

721. Business, Government and Society (3) I II Relationships between the institutions of business and government; economic, social and political aspects. P. 505 or 502. (Identical with Law. 671)
Management Information Systems (MIS)

BPA Building, Room 406
(602) 621-2748

Professors Jay F. Nunamaker, Jr., Head, Raymond Goodman, Benn Konalsy, III, James F. LaSalle, Averill M. Law, Roy E. Marsten

Associate Professor Nicholas Aquilano
Assistant Professors Joey George, Barat Kaku, Susan Saltzman, Olivia Sheng, Asso Yakaharia, Doug Vogel, E. Sue Weber

The department offers a program leading to the Master of Science degree with a major in management information systems. The department also participates in programs leading to the Master of Public Administration, Master of Science, and Doctor of Philosophy (major in business administration) degrees.

Management information systems involves the use of computer organization and the integration of computer skills with the functional areas of management. Education in management information systems enables students to pursue careers in involving the use, definition, analysis, design, implementation, and operation of computer information systems.

To be considered for admission, applicants must have earned a competitive, acceptable score on the Graduate Management Admissions Test and a competitive undergraduate cumulative grade-point average. Applicants must also have completed preparatory work in finite mathematics, statistics, economics, business law, accounting, finance, marketing, organizational behavior, production and business policy.

The program requires the completion of 30 graduate units, including a master's project (698N). Of the 30 units required for the Master of Science degree with a major in management information systems, at least 16 units must be at the 500 and 600 level.

501. Management Information Systems (3) I Introduction to computers and information systems. Use of personal computer productivity tools: word processors, spreadsheets, and database management systems. Current topics such as expert systems and office automation. Open only to students admitted to BPA graduate programs.

507a. Information Systems Architecture and Data Communications (3-3) I and II 507a: Fundamental concepts of operating systems: principles and techniques required for engineering and understanding operating systems will be covered. Examples from real systems. Hardware architecture relevant to the understanding of operating systems. I, P, CR, 531a. 507b: A comprehensive view of data and computer communications. Basic concepts and terminology used in the field, alternative approaches to meeting communication requirements of various users, and the nature and current status of protocol standards will be covered. Emphasis on network design for business applications. I, P, 511a.

511. Readings in Information Systems (3) II Provides a solid conceptual foundation in the structure, development and use of computer-based information systems in organizations. In-depth discussions of a collection of readings that represent classic MIS articles, significant research contributions, notable case studies, and/or technical reports will include information systems perspectives, computers and cognition, decision support systems, expert systems, human-computer interface, and current topics in information systems. (Identical with Acct. 531)

521a-521b. Advanced Systems Modeling and Simulation (3-3) I II The nature of simulation, implementation, and use of simulation in business and social systems. Detailed study of model validation, selecting input probability distributions, random variate generation, statistical analysis of output data. Simulation of manufacturing systems, manufacturing issues addressable by simulation, SIMAN simulation language, and statistical issues in manufacturing simulation. Open only to students admitted to BPA graduate programs. I, P, 552, Math. 119, knowledge of FORTRAN programming, probability and statistics. (Identical with C.S.C. 521a-521b)

522. Mathematical Programming and Applications (3) I II Overview of mathematical programming techniques and business applications. Emphasis on model building and problem description. Open only to BPA graduate students.

531a-531b. Data Structures and Database Management (3-3) I and II 531a: Abstract data types, data structures and their implementation in Pascal systems. Data structures covered include stacks, queues, lists and trees. 531b: Introduction to concepts of database processing in computer systems. Various tools needed for the logical and physical design will be studied in detail. Relational and CODASYL database models, as well as semantic models, will be examined. Implementation aspects of a database system will also be covered.

541a-541b. Computer-Assisted Information Systems Analysis and Design (3-3) Analysis and logical design of M.I.S.; techniques for stating and analyzing information systems requirements; hardware/software selection and evaluation; system implementation and performance evaluation; strategic information systems and decision support systems. Open only to students admitted to BPA graduate programs. (Identical with C.S.C. 541a-541b)

550. Soviet Technology and Science (3) I Introduction to the role of technology and science in the Soviet social, political, and economic environment. Selected assessments of Soviet technical and scientific achievements and problems.


559a. Design and Control of Production Systems (3) I II An introduction to the design of production systems and how decisions about them are influenced. Emphasis on the logical and physical aspects of database management systems and decision support systems. (P, 501 or Math. 119 and 123)

554. Computer Graphics (3) I Introduction to computer graphic display hardware and software components; graphic data structure; pictorial data structures, I, P, 531a.

567. Decision and Control of Production Systems (3) I II An introduction to the design of production systems and how decisions about them are influenced. Emphasis on the logical and physical aspects of database management systems and decision support systems. (P, 501 or Math. 119 and 123)

570. Management and Evaluation of Information Systems (3) I II The methodologies of executive information systems are applied to the problem of designing accounting and management information systems in the hierarchical structure of a profit maximizing firm. An MBA integrative course. Open only to students admitted to BPA graduate programs. P, 501, Econ. 500, Acct. 531, Math. 119, 521a-521b.

572. Operations Management (3) I Intensive study for students without a background in production management. Survey of techniques used in operating manufacturing and service production.


577. Discrete Mathematical Programming (3) Introduction to the formulation, solution, and implementation of discrete and integer mathematical programming models; representative applications will be studied and solved on a computer.

578. Systems Design for Management (3) Decision support systems concepts, applications, and methodologies for developing and evaluating decision support systems. Organization as a technical factor of office automation.


580. Introduction to Expert Systems (3) I An in-depth technical background of the concepts and skills essential to analysis, design and development of business expert systems. Open only to BPA graduate students.

582a-582b. Multivariate Analysis in Management (3-3) 582a: Multiple, polynomial, stepwise regression including indicator variable models, analysis of variance and covariance, principal components, discriminant analysis, canonical correlation. P, 552 or Stat. 275. 582a is not prerequisite to 582b.

585. Material Requirements Planning and Control (3) I II Material management will emphasize on forecasting and inventory theory within a dependent demand environment. 611a-611b. Topics in Research Methodologies in MIS (3-3) 611a: Introduces beginning graduate students to research methods in information systems. 611b: Introduces advanced master's degree students to important research and survey articles in the field of management information systems. 611a discusses research methodologies used in the MIS discipline, including experimental design, survey case studies, field work, and software evaluation.

671. Domestic and International Issues (3) Information technologies and their application in national and international economic, social, and political settings. Open only to BPA graduate students. P, 511 or consult with department before enrolling.

680. Artificial Intelligence and Expert Systems (3) I II Logical and organizational aspects using artificial intelligence (AI) at an expert system technology. Advanced topics such as knowledge acquisition, impacts of AI and expert systems on organizations, and strategic advances of AI and expert system applications will be studied. Cases will be used.


b. Group Support Systems (3)


d. Advances in Optimization Theory (3) P, 552 or Math 289.

e. Recent Advances in Management Science (3) P, 422.
Mathematical Programming (3) P, 422.
Advanced Topics in Data Management (3) P, 531b.
Master’s Report Projects (3) S Open to majors only.
Management of Executive Information (3) II Seminar
Research Issues (3) [Rpt./6 units] Open to majors only.
Workshop
Research Design (3) [Rpt./5] I II P, 796a.

**Marketing (MKTG)**

Building, Room 347

(621)-7479

Mktg Dipankar Chakravarti, Head: Joseph Newman, Lyman E. Oxlund, Robert A. estbrook, John H Wieland (Emeritus) Associate Professors Richard A. Scott, Melanie Waterlot

Department offers a program leading to theter of Science degree with a major in mar- ing. The department also participates in pro- ms leading to the Master of Business in- gestion and the Doctor of Philosophy mes with a major in business administra-

For information concerning these degrees . Requirements for Master’s Degrees/Master **Business Administration** and the headnotes for **Business Administration** elsewhere in this al-

he Master of Science degree program pre- es students for marketing careers whichuire strong empirical research skills. The gram also is an efficient step toward the D. program with a major area of concentra-

in marketing for students holding under-

grades.

for admission, the applicant is expected to ve completed undergraduate work in man-

ancial accounting, economics, finance, mar-

ting, organizational behavior, production, iness policy, statistics, and mathematicsough calculus. Some background require-

ments may be satisfied after admission. A perior score on the Graduate Management imissions Test and evidence of strong aca-

emic performance at the undergraduate level arequired for admission consideration.

Credit earned in fulfilling the backgroundquements named above will not count adward the 39 units of course work required for a M.S. degree. The 39 units include 9 units for a thesis or an internship, one of which is quired.

**Marketing Management (3)** II Scope, orientation and nature of marketing manage-

customer and market analysis for product, service, price, promotion and distribution decisions. Open only to students admitted to P.A. graduate programs.

**Management of Marketing Communications (3)** I Application of communications the-

y and research findings in advertising, sales-romotion, publicity, personal selling; planning, conducting and evaluating of programs of information and persuasion. P, 500.

**Innovation and Economic Growth (3)** I Role of entrepreneurship and innovation in eco-

omic context. Development of the new prod-

ture and assessment of market potential. Open-

t only to students in the entrepreneurship pro-

gram. P, 500, Econ. 500, 510, Fin. 51t. (Identical with Econ. 531b)

**Marketing, Negotiation and Decision Ac-tics (3)** II (Identical with M.A.P. 538)

550. Consumer and Organizational Buyer Behavior (3) I Nature of the purchase decision process for goods and services. Theories, concepts and research methods and findings are examined for understanding and public policy decision making. P, 500.

551. Marketing Decision Support Systems for Managers (3) II Applications of contempo-

raneous computer-based, quantitative models and data analysis techniques to aid marketing man-

agement decisions. P, 500, M.I.S. 552.

554. *Management of Sales Operations (3)* II The sales function and its relationship to the total marketing program; sales strategies and objectives; development and administration of sales organizations; control and evaluation of sales operations. P, 361, M.I.S. 375, Math. 123. *May be repeated with the approval of the instructor.*

555. Industrial Marketing (3) II Problems and methods of marketing decision making in industrial, government and high-tech markets. P, 500.

559. Product Strategy (3) II Formulating and implementing strategy for growth; analyzing and influencing market structure; developing, pricing, testing new entries; managing the port-


560. International Marketing (3) II Marketing planning and strategies for foreign envi-

rments; cultural, political, economic factors affecting the international marketer, multi-

national corporation and multinational market-

groups. P, 500.

563. Environment Scanning (3) II Formulating strategies for foreign environments; re-

search needs; secondary data search methods; interpretation of results. P, 500, M.I.S. 552.

572. Survey and Qualitative Marketing Research Methods (3) I Survey and qualitative research for marketing management informa-

tion needs; secondary data search methods; instrumentation, sampling, field work and data analysis; ethnographic, depth interview and projective methods. P, 500, M.I.S. 552.

673. Experimental Research Methods in Marketing (3) II The design and implementation of marketing experiments. The design and interpretation of the experiment. P, 500, M.I.S. 582a-582b.

695. Colloquium

a. Research in Marketing (1) [Rpt./7] I Seminar

b. Perspectives and Principles for Research in Marketing (3) I


d. Marketing Management and Strategy (3) I 1990-91 P, admission to marketing gradu-

ate program or approval of department.

e. Consumer Behavior (3) I 1989-90 P, admission to marketing graduate pro-

gram or approval of department.

f. Marketing Organization and Systems (3) II 1990-91 P, 696a or approval of in-

stitute department.


Materials Science and Engineering

(See Materials Science and Engineering)

**Materials Science and Engineering (MSE)**

Ines Building, Room 131

(602) 621-6070

Professors Donald R. Uhlmann, Head, William G. Davenport, Louis J. Demer, Kenneth L. Keating, W. David Kingery, David C. Lynch, Thomas M. Morris (Emeritus), Daniel J. Mur-

phy (Emeritus), David R. Poitier, Srini Ragavan, Subhash H. Rastad, Sigmund L. Slichter (Emeritus), Richard A. Swalin, Michael C. Weinberg

Associate Professor Paul D. Calvert

Assistant Professors Dunbar P. Binnie, Pierre A. Deymier, Brian D. Fabels, Brian J.J. Zelinski

The science and engineering of materials hold the key to advances in many critical areas of high technology—from integrated circuits and chip design to turbomachinery and advanced optical waveguides. Besides offering a plethora of such vital applications, the field of materials science and engineering abounds with scientific challenges of the first magnitude. Recognizing the opportunities in the field, the University and the Arizona Legislature have made a major commitment to build a center of excellence on materials.

Based on this commitment, the M.S.E. Department has attracted a group of world-class individuals to its faculty, and has developed a pioneering and wide-ranging cur-

riculum at both the undergraduate and gradu-

ate levels. Funding from the state, the federal government and industry has provided modern facilities and supports research on a broadening scope and magnitude. Much of the research is carried out in our new facilities, the Arizona Materials Laboratories (AML).

The department has exciting research pro-

grams in areas as diverse as high tech ceramics, non-linear optical materials, sol-gel and biomineral processing, and polymers in electronics packaging. It has developed a tradition of excellence in extractive and physical metal-

urgy; the thrust toward high tech materials has yet to be made at a high level.

As an example, our Center for Copper Recovery and Utilization combines strength in hydro-

metallurgy and mineral engineering with the ability to tailor materials for high value applications.

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in materials science and engineering. The programs are divided into the areas of specialization as follows:

**Degrees**

Master of Science: The course requirements for the Master of Science degrees include courses from 500 level courses including M.S.E. 510; 4 units of colloquium, independent study, or regularly scheduled graduate courses; and 8 units of the 700 level.

Students may take up to six units of course work completed at other institutions accredited for graduate work. This transfer of graduate credit must be requested from the Graduate College by the student after he or she has satisfactorily completed one semester of work at the University of Arizona. A student must take a minimum of 20 units of work in residence.

Applicants with undergraduate backgrounds in materials science and engineering or in related science disciplines such as chemistry, geology, physics, or other related engineering fields are admitted to the Master of Science program. Graduate students entering the program for other than the above related science disciplines, such as chemistry, geology, physics, or other related engineering fields are admitted to the Master of Science program. Graduate students entering the program for other than the above related science disciplines, such as chemistry, geology, physics, or other related engineering fields are admitted to the Master of Science program.

In certain cases, graduate credit may be earned for such courses.

**Doctor of Philosophy**: A graduate study pro-

gram will be designed to ensure that each stu-
dent acquires a thorough understanding of advanced materials and an in-depth knowledge of an appropriate minor. The dissertation, based on original research, is expected to represent a distinct contribution to materials knowledge. It should emphasize the candidate's capability of independent, original, and creative thinking. It is not necessary that the research be entirely on a scientific aspect of materials, but must demonstrate a well-organized and well-developed consideration as well as scientific aspects of the problem.

As a general policy, applicants with an M.S. degree are not required to have a minimum of one semester of advanced coursework in science and engineering or an allied field, that includes the completion of a thesis, will be admitted to the Ph.D. program. Successful completion of the Ph.D. program in the department of Materials Science and Engineering includes the completion of at least 72 units of graduate courses beyond the B.S. degree. This will include: (a) 30 units (max.) from a completed M.S. degree program, courses in a minor program and 18 units of dissertation credit; (b) completion of specific courses such as M.S.E. 510 (or its equivalent) and M.S.E. 513 (or its equivalent) as well as at least 9 units of 500 level courses in the department.

503. Applied Surface Chemistry (3) I Fundamentals of surface phenomena, characterization of solid-vapor, solid-liquid and liquid-vapor interfaces, applications in ceramics, electronics and biomedical materials processing. P, a basic course in chemistry or materials science. 4, 5, 254.


523.* Electrochemistry in Materials Science (3) I Principles and applications of electrochemistry in the processing of materials through characterization of surfaces, interfaces, plasmas, complex equilibria, silicate chemistry, and super-critical fluids. P, 240.


531.* Science and Technology of Magnetic Recording Materials (3) I Magnetic properties of materials, materials for magnetic recording, technology of magnetic recording, P, a basic course in chemistry or materials science.

532. Solid-Fluid Reactions (3) I (Identical with Ch.E. 532)


535.* Corrosion (3) I The science of corrosion reactions and their application to engineering problems. P, 331R or Che. 480b or CR. (Identical with Ch.E. 535)

536. Advanced Microstructural Characterization (3) I Transmission and scanning electron microscopy, microprobe, X-ray microanalysis, energy dispersive X-ray analysis. 2R, 3L. Field trips. Consult department before enrolling.

540.* Thermodynamics of Condensed Phases (3) I Advanced treatment of the principles of thermodynamics with applications to electronic and optical materials; emphasis on solutions, defect chemistry and modeling of multicomponent systems. P, 240.

550L.* Materials Processing Laboratory (1) I Laboratory experiments in solidification and mechanical forming processes. P, CR 450R.

551. Atomistic Computational Techniques in Materials Science (3) II Monte Carlo and molecular dynamics techniques; application to calculation of materials properties (structural, mechanical, electronic, magnetic, transport, defect), other solid-state physics phenomena, other statistical mechanics or statistical thermodynamics course.

552.* Nondestructive Evaluation of Materials (3) II Introduction to the nondestructive testing and evaluation of the various classes of engineering materials. Methods considered include leak detection, penetrant, electromagnetic, dielectric, radiographic, acoustic, optical, eddy current, acoustic emission, and thermal. 2R, 3L. P, 311R or 360, or CR.

557. Integrated Circuit Technology Laboratory (3) II (Identical with E.C.E. 557)


561.* Biological and Synthetic Materials (3) II Structural materials in biology include fibers (tendon and silk), rubber (elastin), composites (bone) and ceramics (teeth and shells). Their properties are compared with synthetics. P, Chem 503a.

570. Technology of Polymers and Ceramics (3) I Processing and properties of glasses and ceramics in a wide range of technological applications. P, 260 or 331R. Chem. 503a.

571. The Formation and Structure of Glass (3) [Rpt./2] II The glass transition, Kauzmann's paradox, structure of glass, formation of glass, glassy state. P, General Physics, chemistry of glass making, glass structure, thermal properties. P, 470 recommended but not required.


545. Colloquium (1) I (Rpt./5) I


652. Statistical Thermodynamics in Materials Science (3) II Introduction to statistical mechanics, as applied to materials science. Electronic properties of materials, statistical mechanics, applications of thermodynamics to problems of materials science. P, 510 or other classical thermodynamics course.

Mathematics (MATH)

Mathematics Building, Room 117
(602) 621-2868

(See also Applied Mathematics)

Professors Alan C. Newell, Head, Clark T. Benzoni, Assistant Professors Moysey Brio, Paul Fan, Lou Haine, William G. McCallum, Yong-Quan Ye

The department offers programs leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees in mathematics. Concentrations are available in pure mathematics, applied mathematics, and 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 and the College of Education, and also offer work leading to the Master of Education degree in mathematics. For information concerning the degree see Requirements for Master's Degree in Mathematics. Mathematics courses are also offered for the 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 undergraduate mathematics. In addition, they should establish the fact that the candidate is capable of independent study and original research, is expected to represent a distinct contribution to mathematics knowledge. It should emphasize the candidate's capability of independent, original, and creative thinking. It is not necessary that the research be entirely on a scientific aspect of mathematics, but must demonstrate a well-organized and well-developed consideration as well as scientific aspects of the problem.
ponents in master's degree programs are ed to pass the Computer Programmingation of the Department of Mathematics part of the graduate program.

385Arts: This program is for students who wish to combine mathematics with some discipline. The program must include at least nine and twelve units of approved outside the department. No thesis is red.

ter of Science: This program is for stu- who wish to earn all of their graduate is for students in their last quarter graduate units, the contents are needed, some in required courses covered on the oral exam. A is not required, but up to six units may be id if the student elects to submit one.

ctor of Philosophy: The major course work ists of at least 36 graduate mathematics . Of these, several will be in basic courses ed on the preliminary exam. Commonly minor, consisting of at least 12 units of and courses, is within the department in a neration different from the major. A minor istics, courses outside the departmen tment is also encouraged. There is a lan- ge requirement which can be satisfied in two of the following: French, German, Rusk, or Spanish. The principal p point of the program is the completion of issertation involving original creative ar. Ph.D. candidates with other majors with minor in mathematics are required ke four graduate level courses in mathematics and a written examination which covers the ent of those courses.

eculty of the Department of Mathem- cares on research (and research semi- j) in a variety of purely mathematical and disciplinary fields. In algebra and number theory, research includes finite groups, rings, ictive algebras, algebraic number theory, primality testing. Research in analysis is carried out on unbounded operators, intum fields, relativinity, and nonlinear prob- s of ecology, chemistry, and fluid dynam- metry. In geometry, there is work on convex sets, dence geometry, and fibre bundles; in baby, theoretical projects involve topology, s, reliability theory, and nonparametric reence. A detailed summary of faculty ear appears yearly and is available on line.

4 Mathematical Logic (3) II 1989-90 Sen- tential calculus, predicate calculus; consis- cy, independence, completeness, and the ision problem. Designed to be of interest to ors in mathematics or philosophy. P, 124 or if 325. (Identical with CSc, 502)

1. Foundations of Mathematics (3) II 0-91 Topics in set theory such as functions, stions, direct products, transfinite induction edition, cardinal and ordinal arithmetic; istic set theory and the development of the real number system, recur- fuctions. P, 215. (Identical with Phil 503)

1. History of Mathematics (3) I The velopment of mathematics from ancient es through the 17th century, with emphasis problem solving. The study of selected ces from each field is extended to the 20th tury. P, M.A., M.S., or Ph.D. gr for math majors. P, 125b.

1a-511b. Modern Algebra (3-3) Structure of xps, rings, modules, algebras; Galois the- t. P, 215.


514a-514b. Algebraic Number Theory (3-3) 1989-90 Dedekind domains, complete fields, class groups and class numbers, Dirichlet unit theorem, algebraic function fields. P, 215b.

515. Introduction to Algebra (3) I Introduction to groups, rings, and fields. P, 423.

516. Applications of Algebra (3) II Various applications of abstract algebra, e.g. to coding theory, combinatorial designs, cryptography, etc. P, 215.

517a-517b. Group Theory (3-3) 1990-91 Selections from such topics as finite groups, automorphism groups, abelian groups, characters and representations. P, 215b.

518. Topics in Algebra (3) [Rpt.] II Advanced topics in groups, rings, fields, algebras: content varies.

519. Topics in Number Theory and Com- binatorics (3) [Rpt.] II Advanced topics in algebraic number theory, analytic number the- ory, class fields, combinatorics; content varies.


521. Fourier Series and Orthogonal Func- tions (3) I Linear spaces, orthogonal functions, Fourier series, Legendre polynomials and Bessel functions. P, 254 or 255.

522a-522b. Advanced Analysis for Engi- neers (3-3) 1990-91 Theory and examples of linear differential equations, vector analysis, integral theorems, matrices, complex variables. Credit allowed for 522a or 522b, but not both. Not applicable to M.A. or Ph.D. gr for math majors. P, 254 or 255.


524. Elements of Complex Variables (3) I II Complex numbers and functions, conformal mapping, calculus of residues. P, 223.

525. Advanced Calculus I (3) I Continuity and Riemann integration in one or two dimen- sions, infinite series, uniform convergence, differentiation in n-space, inverse function theorem. P, 223 and 423.

526. Advanced Calculus II (3) II Curves, surfaces, change of variable, multiple integrals; extremal problems; theorems of Green, Gauss, and Stokes; exact differentials. 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, oper- rations, and topological vector spaces. P, 529a or 529b.

530. Second Course in Geometry (3) II 1990-91 Topics to be selected from projective geometry, algebraic geometry, metric geometry, and inner geometries. P, 423 or 425.

531. Calculus of Variations (3) I 1989-90 Euler equations and basic necessary condi- tions for extrema, sufficiency conditions, intro- duction to optimal control, direct methods. P, 254 or 255.

534a-534b. Topology (3-3) I II Point set topol- ogy, homotopy, homology. Applications, such as manifolds, duality, fixed point theorems, solutions to differential equations. P, 415, 425.


538. Topics in Geometry and Topology (3) [Rpt.] I II Advanced topics in point set and algebraic topology, elementary differential geometry; content varies.

539. Algebraic Coding Theory (3) II 1989-90 Construction and properties of error correcting codes; encoding and decoding procedures and information rate for various codes. P, 415. (Identical with ECE, 539)

543. Theory of Graphs and Networks (3) II Undirected and directed graphs, connectivity, circuits, trees, partitions, planarity, coloring problems, matrix methods, applications in diverse disciplines. P, 215 or 223 or 243. (Identical with CSc, 543)


547. Combinatorial Mathematics (3) II 1990-91 Enumeration and construction of arrangements or designs, theorems on exist- ence, and applications to combinatorial problems on design of experiments and error correcting codes. P, 215 or 243.


553a-553b. Partial Differential Equations (3-3) 1990-91 Theory and examples of linear equations; characteristics, well-posed problems, regularity, variational properties, asymptotics. Topics in nonlinear equations, such as shock waves, diffusion waves, and estimates in Sobolev spaces. P, 523b or 527b or 583b.


557a-557b. Dynamical Systems and Chaos (3-3) 1990-91 Qualitative theory of dynamical systems, phase space analysis, bifurcation, period doubling, universal scaling, onset of chaos. Applications drawn from atmospheric physics, economics, biology, ecology, fluid mechanics and optics. P, 422a-422b or 454.


563a-563b. Probability Theory (3-3) 1990-91 563a: Introduction to measure theory, strong law of large numbers, characteristic functions, the central limit theorem, conditional expecta- tions, and discrete parameter martingales. P,


571. Theory of Computation (3) II (Identical with C.S.C. 571)

573a-575b. Numerical Analysis (3-3) Error analysis, solution of linear systems and nonlinear equations, eigenvalues and eigenvectors, interpolation and approximation, numerical integration, initial and boundary value problems for ordinary differential equations, optimization, P. 475b, and 455 or 456.

577. Topics in Applied Mathematics (3) [Rpt.] II Advanced topics in asymptotics, numerical analysis, approximation theory, mathematical theory of quantum mechanics, dynamical systems, differential equations and inequalities, mathematical theory of statistics; content varies.

578. Computational Methods of Algebra (3) II Applications of machine computation to various aspects of algebra, such as matrix algorithms, character tables and conjugacy classes for finite groups, coset enumeration, integral matrices, crystallographic groups. P. 415 and a knowledge of scientific computer programming language. (Identical with C.S.C. 578)

579. I Game Theory and Mathematical Programming (3) II 1989-90 Linear inequalities, games of strategy, minimax theorem, optimal strategies, duality, simplex method. P. 410 or 413 or 415. (Identical with C.S.C. 579)


583a-583b. Principles and Methods of Applied Mathematics (3-3) Boundary value problems; Green's functions, distributions, Fourier transforms, linear waves, classical partial differential equations (Laplace, heat, wave) of mathematical physics. Linear operators, spectral theory, integral equations, Fredholm theory. P. 422b or 424, or CR 529a.

584. I Operational Mathematics (3) I Basic concepts of systems analysis, Fourier and Laplace transforms, difference equations, stability criteria. P. 421 and 424, or 422b.

585. I Mathematical Modelling (3) II Development, analysis, and evaluation of mathematical models for physical, biological, social, and technical problems; both analytical and numerical solution techniques are required. P. 421, CR 475b, S.L.E. 230.

586. Case Studies in Applied Mathematics (1-3) [Rpt./6 units] I In-depth treatment of several contemporary problems or problem areas from a variety of fields, but all involving mathematical modeling and analysis; content varies.

587. Perturbation Methods in Applied Mathematics (3) I 1989-90 Regular and singular perturbations, boundary layer theory, multiscale and advection methods for nonlinear waves and oscillators. P. 422a-422b or 454.

588. Topics in Mathematical Physics (3) [Rpt.] II Advanced topics in field theories, mathematical theory of quantum mechanics, mathematical theory of statistical mechanics; content varies.

589. Nonlinear Wave Motion (3) II 1989-90 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 455 or 456.

596. Seminar I Topics in Mathematics (3) [Rpt./1] S a. Mathematical Software (3) [Rpt.] I II P. 254 or 255, knowledge of "C" programming.

598. Information Theory and Coding (3) II 1989-90 (Identical with E.C.E. 636)

Medicine (MED/ANES/FCM)

Arizona Health Sciences Center, Room 2205 (602) 626-7383

Interdepartmental (MED)

595. Colloquium y. Introduction to the Neurosciences I (2) 1989-90 P. Consult department before enrolling. (Identical with Anat. 595y)

596. Seminar Many interdepartmental seminars are numbered at both the 500 and the 800 levels. See 896 below for a complete listing.

801. Preparation for Clinical Medicine (1-12) II No grade is given until the full 12 units are completed.

802. Human Behavior and Development (6) I

830. Supplementary Registration (1-9)

896. Seminar a. Introduction to Forensic Pathology (1) Physical and Biological Basis of Nuclear Medicine (2) c. General Anesthesiology (3) d. General Anesthesiology (4-6)

Biochemistry

See Biochemistry elsewhere in this catalog.

Cancer Biology

See Cancer Biology elsewhere in this catalog.

Family and Community Medicine (FCM)


Research (2-16) [Rpt./2]. P. Basic science courses.

515. Subspecialty a. Cancer Epidemiology and Prevention I P. Statistics helpful. (Identical with R.Onc. 515h)

587. I Poverty and Health (3) II (Identical with Nurs. 587)

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

595. Colloquium d. Special Topics in Cell Biology (2) [Rpt. units] II Open to students in biology sciences only. (Identical with Anat. 595d, Med. 595d, R.Onc. 595d)

596. Seminar a. Introduction to the Neurosciences I (2) II No grade is given until the full 12 units are completed.

801. Preparation for Clinical Medicine (1-12) II No grade is given until the full 12 units are completed.

802. Human Behavior and Development (6) I

830. Supplementary Registration (1-9)

896. Seminar a. Introduction to Forensic Pathology (1) Physical and Biological Basis of Nuclear Medicine (2) c. General Anesthesiology (3) d. General Anesthesiology (4-6)

Note: Some seminars are numbered at both the 500 and the 800 levels. See 896 below for a complete listing.
Family Medicine (3-12) P, 4th year medical student. Consult department before enrolling.

Epidemiology at CDC (3) I II P, open to majors in medicine, public health, and nursing. Consult department before enrolling.

Rural Care (4-12) 

Prison Health Care (3-6) Consult department before enrolling. Clinical Preceptorship in International Health (6-12) 

AHEC/Border Health (4-12) Consult department before enrolling. 

Subspecialties and Practice of Home Health Health (2) I II Consult department before enrolling. The Doctor-Patient Relationship (2) 

Crisis and Conflict: Health Services in Latin America-Brazil (2) 

Nutrition in Diseases (1-2) [Rpt./1] P, Bioc. 801, 803, 601, 801. 

Alternative Strategies for Coping with Illness: A Cross-Culture View (2) II 

Primary Care of Community-Oriented Medicine in Rural Areas (2) II 

Community and International Nutrition (1-3) II 

Prepaid Health Care (1) [Rpt.] II Consult department before enrolling. 

Basic Principles of Epidemiology (3) [Rpt./1] 

AIDS, Cancer, Nutrition Immunity (1) II 

Tropical Disease Problems (2) I 

Current Issues in Health Services (2) I 

Diet and Prevention of Disease (2) I 

Psychosocial Epidemiology (2) 

i. 891. Preceptorship 

a. General Medicine and/or Subspecialties (3-12) [Rpt./2] 

b. Ambulatory Internal Medicine: Clinical Problems (6) 

892. Seminar 

a. Pathophysiology and Immunology of the Clinical Manifestations of Coccidioidomycosis (2) II 

Microbiology and Immunology 

See Microbiology and Immunology elsewhere in this catalog.

Neurology (NEUR) 

Professors Alan B. Rubens, Head, Peggy Ferry (Pediatrics), William A. Sibley 

Associate Professor Colin R. Bamford 

Associate Professors William Feinberg, Steven Rapcsak 

595. Colloquium 

y: Introduction to the Neurosciences I (2) 1989-90 P, Consult department before enrolling. (Identical with Med. 595y, which is home) 

y: Introduction to the Neurosciences II (2) 1989-90 P, Consult department before enrolling. (Identical with Med. 595z, which is home) 

800. Research (1-12) [Rpt./1] (See College of Medicine Electives Manual) 

803. Clinical Clerkship (3-6) 

810. Clerkship 

a. Neurology (3-6) 

815. Subspecialty 


b. Cerebrovascular Disease (3) P, 803. 

891. Preceptorship 

a. Neurology (1-18) [Rpt./2] 


Obstetrics and Gynecology (OBG) 

Professors C. D. Christian, Head, Jack Pearson, Lewis Shenker, Louis Weinstein 

Associate Professors Diane S. Fordney, Kathryn Reed, William C. Scott 

800. Research (1-18) [Rpt./1] 

803. Clinical Clerkship (5-9) 

810. Clerkship 

a. Preparation for Practice (1-18) 

815. Subspecialty 

a. Clinical Infertility (4-6) I II S 

891. Preceptorship 

a. Obstetrics and Gynecology (1-18) 

b. Gynecology-Endocrinology (6) 

Ophthalmology (OPHT) 

Professor Barton L. Hodes, Head 

Assistant Professors William D. Mathers, Kenneth B. Simons 

800. Research (6-18) I II 

815. Subspecialty 

a. Ophthalmology (3-6) 

891. Preceptorship 


Pathology (PATH) 


Associate Professors James M. Byers, III, Anna R. Graham, Thomas M. Grogan, Mary Jane Hicks, Douglas H. McKelvie, Ronald Schifman 

801. General and Systemic Pathology (10) I II 

810. Clerkship 

a. Anatomic Pathology (1-18) 

b. Clinical Pathology (1-18) 

c. Special Topics (1-18) [Rpt.] P, 801. 

891. Preceptorship 

a. Pathology (1-18) [Rpt./2] 

Pediatrics (PED) 


Associate Professors John J. Hutter, Michael J. Schumacher, Elsa Sell, John N. Udall, Jr., Alayne Yates 

Assistant Professors Alan D. Bedrick, Richard L. Donnerstein, Carlos A. Flores, Daniela Lax, Thomas R. Lloyd, Paul F. Pollack, William A. Scott, Ziad M. Shehab 

800. Research (1-18) (See College of Medicine Electives Manual) 

803. Clinical Clerkship (6-9) 

810. Clerkship 


b. Pediatric Care in a Cross-Cultural Setting (6) 

c. Inpatient Pediatrics (6) 

d. Inpatient Pediatrics (6) [Rpt./1] Yr. 4 

815. Subspecialty 

a. Advanced Neonatology (6) 

b. Pediatric Infectious Diseases (6) 


d. Cardiac Ultrasound Echo and Doppler (4-6) 

e. Pediatric Cardiology (6)
Pharmacology

See Pharmacology elsewhere in this catalog. Toxicology courses are listed under Pharmacology and Toxicology.

Physiology

See Physiology elsewhere in this catalog.

Psychiatry (PSYI)

Professors Alan I. Levenson, Head, Allan Beigel, Larry E. Beutler (Psychology), Richard R. Bootzin (Psychology), Henry W. Brotzman, Alfred W. Kaszniaik (Psychology), Mary P. Koss, Alyane Yates

Associate Professors Harold S. Arkowitz (Psychology), Diane S. Fordney (Obstetrics and Gynecology), David Nelson (Pharmacology and Toxicology), Catherine M. Shisslak (Psychology), Henry I. Yamamura (Pharmacology)

Assistant Professors Peter J. Attarian (Family and Community Medicine), Shirley N. Fahey, Milton Frank

959. Colloquium
z.1 Introduction to the Neurosciences II (2) 1989-90 P, 595y or consult department before enrolling. (Identical with Med. 595z, which is home)

†May be convened with 400-level course.

800. Research (1-2) (See College of Medicine Electives Manual)

803. Clinical Clerkship (6-9) [Rpt./1]

810. Clerkship
a. Clinical and Community Psychiatry (1-8)
b. Child Psychiatry (1-8)

815. Subspecialty
b. Forensic Psychiatry (3-6) II I S, 803.

891. Preceptorship

Radiation Oncology (RONC)

Professors J. Robert Cassidy, Head, G. Timothy Bowden, Thomas C. Celas, Eugene W. Gerner, Robert B. Roemer

Associate Professors Daniel L. McGee, Jeffrey Trent

Assistant Professors Anne E. Cress, Kullervo Nymoen, Bruce Lulu, Wendell Lutz, David Shimm, Baidassaree D. Stea

501. Radiation Biology (3) II Basic principles of radiation effects in mammalian cell and tissue systems, with emphasis on biochemical aspects, such as DNA damage and DNA repair, and cellular responses, such as cell kinetics defects and radiation repair and recovery; radiation and chemical (especially radio-mimetic drug) carcinogenesis. P, introductory biology and chemistry.

515. Subspecialty
h. Cancer Epidemiology and Prevention (3) P, statistics helpful. (Identical with F.C.M. 515h, which is home)

551. Environmental Carcinogenesis (3) II 1990-91 See R onc. 851 for description. (Identical with C.Bio. 551)

555. Cancer Biology (3) II 1990-91 (Identical with Micr. 555)

595. Colloquium
d. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with C.Bio. 595d, which is home)

599. Seminar
h. Control of Proliferation in Animal Cells (1-2) I P, consult department before enrolling. (Identical with Micr. 599h)

815. Subspecialty
a. Introduction to Radiation Oncology (1-6)
b. Cancer Epidemiology and Prevention (3) P, statistics helpful. (Identical with F.C.M. 815b, which is home)

851. Environmental Carcinogenesis (3) II 1990-91 Phenomenological and mechanistic aspects of cancer etiology as induced by physical and chemical agents in our environment, with special emphasis on possible molecular and cellular mechanisms involved in cancer etiology, P, consult department before enrolling. (Identical with Micr. 851)

896. Seminar
h. Control of Proliferation in Animal Cells (1-2) I (Identical with Micr. 896h)

Radiology (RAI)

Professors Paul Capp, Head, Harrison H. Barrett (Optical Sciences), Theodore Bowen (Physics), William Dallas, Bruce J. Hillman, Tim B. Hunter, Theron W. Vovit, Dennis D. Patton (Optical Sciences), Michael J. Pitt (Surgery), Arthur J. Present (Emeritus), Joachim F. Seeker, William L. Wolfe, Jr. (Optical Sciences), James M. Woollenden

Associate Professors John C. Bjelland, Ray mond Carmody, Robert E. Henry, Gerald D. Pond, Bryan Westminster

Assistant Professors Arthur F. Gmitro, Evan C. Unger, Walter H. Williams

The Department of Radiology includes the University Medical Center Divisions of Diagnostic Radiology and Nuclear Medicine.

800. Research (1-6) [Rpt./1]

815. Subspecialty
a. Diagnostic Radiology (4)
b. Nuclear Medicine (1-6)

891. Preceptorship

Surgery (SURG)


Associate Professors Kenneth V. Isserlin, Edward C. Percy, Arthur B. Sanders, John B. Sullivan

Assistant Professors James B. Benjam in, Janis M. Bur (Physiology), Gary L. Dunnington, Robert P. Hendry, Timothy B. Icenogle, Stanley P.L. Leong, Kenneth E. McIntyre, Daniel W. Spaite, Terence B. Valenzuela, David B. Van Wyck (Internal Medicine), M. Andre Vasu

800. Research (1-12) P, 803. (See College of Medicine Electives Manual)

803. Clinical Clerkship (6-9)

807. Specialty Clerkship (3) P, basic science courses.

810. Clerkship
a. General Surgery (6)

815. Subspecialty
a. Urinary Stone Disease (6)
b. Cardiothoracic Surgery (6)
c. Neurosurgery (6)
d. Surgical and Medical Problems in Endocrine and Electrolyte Balance (1-3) [Rpt./1]
e. Urology (6)
f. Orthopedics (3)
g. Cardiovascular Physiology and Respiration (3)
h. Lymphovascular System in Health (6-12)

i. Otorhinolaryngology (3)
j. Sports Medicine (Section of Ortho Surgery) (1-6) [Rpt./1]
l. Orthopedic Bioengineering (3-6) P I weeks of surgery clerkship, 803 at 807.
m. Trauma (3-6)

n. Spinal Cord Injury (3) Open to only P, senior standing.
a. Surgical Critical Care (3-6) [Rpt./1]

c. Clinical Experience in Rehabilitation Medicine (1-4)
d. Vascular Clinical Management (6) [Rpt./8 units] P, completion of junior year.

891. Preceptorship
a. Surgery and Subspecialties (1-18) [Rpt./1]

896. Seminar
a. Medical Ignorance (2) [Rpt./1] II

Medieval Studies

Social Sciences Building, Room 126 (602) 621-1586

Committee on Medieval Studies (Graduate)

Professors John Boe (Music), Sigmund Eis (English)

Associate Professors Alan E. Bernstein (History), Chairperson, Jonathan Beck (Fellow), and Richard C. Jensen (Classics)

The Graduate Committee on Medieval Studies does not offer any major at this time. Prospective constituent appropriate minors are available 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 coursework (note that no course may serve a major or minor). A reading knowledge of either classical or medieval Latin, knowledge of an old form of one language (language majors, this requirement is in addition to the major field); a course in medieval history or culture such as art (for non-art major music majors, or philosophy or non-philosophy majors).

Related Courses

Refer to the appropriate department for course descriptions and unit values. Among the
520L.* Pathogenic Bacteriology Laboratory (2) II Isolation and identification of pathogenic bacteria; techniques in pathogenic bacteriology. P, or CR, 420R. (Identical with V.Sc. 520L)
523R.* General Pathology (3) II (Identical with V.Sc. 523R)
523L.* General Pathology Laboratory (1) II (Identical with V.Sc. 523L)
527L.* General Mycology Laboratory (2) I General mycology laboratory, with emphasis on the microfungi. P, or CR 257R.
528R.* Advanced Microbial Genetics (3) II (Identical with M.C.B. 528R)
528L.* Advanced Microbial Genetics Laboratory (2) I (Identical with M.C.B. 528L)
530.* Introduction to Biophysics (2) I (Identical with Phys. 530)
531.* Biophysical Theory (2) II (Identical with Phys. 531)
535.* Soil Microbiology (3) I (Identical with S.W. 535)
536.* Ecology of Infectious Disease (3) II 1990-91 Factors involved in the epidemiology of infectious disease. P, 419R or 420R. (Identical with V.Sc. 536)
545.* Microbiology of the Rhizosphere (2) II 1990-91 (Identical with S.W. 545)
550.* Medical Microbiology (4) II The isolation and identification of fungi of medical importance. 2R, 6L. P, 205. (Identical with V.Sc. 550)
551.* Environmental Carcinogenesis (3) I 1989-90 (Identical with R.Onc. 551)
552.* Molecular Mechanisms of Microbial Pathogenesis (3) I 1990-91 Review of current concepts in specific areas of microbial pathogenesis, including action of exotoxins, cell surface interactions, phagocytosis and host microbical functions. P, Bioc. 460.
554.* Cancer Biology (3) II 1990-91 Fundamentals of basic aspects of malignancy with the organ, cellular, and molecular levels; emphasis on the etiology, biology, and therapy of neoplasms. Coreq., with: 555. C.Bio. 555, I Med. 555, and R.Onc. 555)
561. Immunobiology (3) II 1990-91 Cells and cellular events involved in humoral and cellular immune responses; morphologic, physiologic, and biochemical characteristics of the lymphoreticular system. P, Bioc. 462a-462b.
570. Molecular Genetics (3) I 1989-90 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 (lysogenic, transduction, conjugation, use of transposons and gene fusions in bacteria; genetic transformation); introduction to gene cloning and its uses in analysis of gene structure and regulation. (Identical with Gene. 570)
571. Molecular Gene Cloning (3) II 1990-91 Current gene cloning technology; restriction endonucleases, cloning vehicles (plasmid vectors, bacteriophage vectors, and single stranded phage vectors), gene amplification, and expression of cloned genes. (Identical with Gene. 571)
573.* Recombinant DNA Techniques (3) II (Identical with M.C.B. 573)
582. Immunotoxicology (2) I (Identical with Tox. 582)
589. Colloquium d. Special Topics in Cell Biology (2) [Rpt./6 units] (Identical with C.Bio. 595d, which is home)
596. Seminar a. Current Problems in Molecular Bio- physics (1) I (Identical with Phys. 596a, which is home)
b. Cancer Genetics and Cytogenetics (3) I 1989-90 (Identical with C.Bio. 596f, which is home)
h. Control of Proliferation in Animal Cells (1-2) I (Identical with R.Onc. 596h, which is home)
630. Immunology of Infectious Disease (4) II 1989-90 Methods for investigating changes in humoral and cellular immunity during the disease process. Laboratory and library work for the preparation of a grant using NIH or NSF format. 12L. P, 419R, 560 or 561. Bioc. 460. Consult department before enrolling. (Identical with V.Sc. 630)
672. Food Safety (2) I 1989-90 (Identical with N.F.S. 672)
695. Colloquium a. Readings in Microbiology (1) [Rpt./1] III
b. Immunopathology (1) III
c. Molecular Genetics of Microorganisms (1) III
d. Molecular and Cellular Immunology (1) II
f. Tumor Virology (1) II
g. Host-Parasite Interactions (1) [Rpt./1]
696. Seminar a. Research (1) [Rpt./1] III
801. Medical Microbiology (6)
851. Environmental Carcinogenesis (3) II 1990-91 (Identical with R.Onc. 851)
891. Preceptorship a. Microbiology and Immunology (3-12) [Rpt./12 units]
896. Seminar h. Control of Proliferation in Animal Cells (1-2) I (Identical with Radi. 896h, which is home)

Mineral Economics (See Mining and Geological Engineering)

**Mining and Geological Engineering (GEN/MNEC/MNE)**

Mines Building, Room 229
(602) 621-2147

Professors Ian W. Farmert, Acting Head, DeVerle P. Harris, Y.C. Kim, Richard Newcomb, William C. Peters (Emeritus), Michael Rieber Associate Professors Jaak J.K. Daemen, Charles G. Glass, Pinnadu Kulatilake, Ben K. Stemberg
Assistant Professor Satya Hapalar

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees in mineral engineering, geological engineering, and mineral economics. Advanced work in mining engineering is directed toward research and professional development in several fields including mine
planning, geomechanics, operations research, robotics, mine health and safety, and the development of effective training programs. Advanced work in geological engineering is directed toward the fields of geophysical engineering, ground stabilization, earthquake engineering, and remote sensing and conservation. Geomatics is a field of applied economics encompassing the interface of mineral engineering and earth science with the business of mineral production and the setting of public policy.

Admission to graduate work normally requires the completion of an undergraduate major in these fields. A minimum of three years of undergraduate study, particularly in mathematics, geology, and physical sciences, is required. Students often complete a bachelor's degree in chemical, geological, or earth sciences with a concentration in geologic mapping or geophysical methods. Earth sciences include geology, geophysics, mineralogy, and geomatics.

Mineral Economics (MNEC) 500. Economics of Mineral Resource Development and Production (4) I Concessions and methods of mineral economics; analysis selected mineral and energy commodities, including petroleum; economic factors in ore procurement, production, and transportation; and environmental issues. P. Econ. 361. (Identical with Mn.E. 500)

518. Mine Investment Analysis (3) II (Identical with Mn.E. 518)

520. Economics of the Metal Industries (3) Reserves, resources, and major deposits, production technologies, market structure, industrial organization, investments, consumption, recycling, foreign trade, and political issues. P. A.Ec. 504.

525. Economics of the Nonmetal (3) Technology of production, raw materials, used and marketed, industrial organization, market structure, economics of production, pricing, and marketing practices for nonmetal commodities. P. A.Ec. 504.

534. Economics of Coal, Nuclear, and Alternative Energy Sources (3) I Reserves, resources, and production technologies, market structure, industrial organization, pricing, and market policy issues. P. A.Ec. 504.

537. Minerals and Economic Development (3) Concepts, conflicts, and case studies in the development of mineral resources, industry, and host countries. P. Econ. 361.

540. Readings in Mineral Economics (3) Readings in the economics of mineral resource exploration and exploitation, environmental protection, national mineral policy, and mineral development and international trade. P. Econ. 361.

545a. Advanced Topics in Mineral Economics (3) Risk analysis; optimization; decision theory; probability distributions, sampling distributions, confidence intervals, hypothesis testing, goodness of fit; and theoretical and practical problems in economic analysis. P. Econ. 361.

571. Advanced topics in Geotechnical Engineering (3) I (Identical with Mn.E. 571)

584. Economics of Coal, Nuclear, and Alternative Energy Sources (3) I Reserves, resources, and production technologies, market structure, industrial organization, pricing, and market policy issues. P. A.Ec. 504.

585. Fundamentals of Industrial Hygiene (3) I (Identical with O.S.H. 585)


595. Stress and Strain Analysis (3) I (Identical with Mn.E. 595)

597. Computer Methods in Geotechnical Engineering (3) I Use of computers to solve problems in geotechnical engineering, including data bases, computer contouring, map filtering and enhancement, and multivariate analysis of geologic data. P. Introductory courses in computer programming, math, and earth science.

598a. Fundamentals of Industrial Hygiene (3) I (Identical with O.S.H. 598a)


650a-560b. Estimation of Mineral Resources by Quantitative Methods (3-3) 1989-90 Estimation of mineral resource potential and its application to mineral resource exploration and exploitation; environmental protection, national mineral policy, and mineral development and international trade. P. Econ. 361.

696. Seminar I a. Research (3-1) I Rpt. I I (Identical with G.E. 696a, which is home)

b. Advanced Topics in Mineral Evaluation and Risk Analysis (3-1) Rpt. I I I

1. Advanced Mineral Commodity Analysis (3-3) [Rpt./3 units] III
2. Topics in Mineral and Energy Supply (1-3) [Rpt./3 units] III
3. Decision Analysis and Operations Research in Mineral Exploration (1-3) [Rpt./3 units] III
4. Process Analysis and Costing (1-3) [Rpt./3 units] II

**Ingeering (MNE)**

1. Economics of Mineral Resource Development and Production (4) I [Identical with Mn.Ec. 500]
2. Analysis of Mine Operations (3) I Use operations research principles and techniques to analyze various problems in mine operations. P, 402 or a knowledge of probability. Harpalani
3. Probability and Statistical Concepts in Mining Media (4) I [Identical with G.E. 502]
4. Analysis of Mining Decisions (3) I Use probabilistic, simulation models to analyze mining projects to determine the most economical method of operation. P, 402, 430. Kim
6. Accident Prevention (2) II Concepts and case histories in recognition, evaluation and control of health and safety hazards encountered in industrial situations. P, 427 or 527. (Identical with Bioc. 510)
7. Modern Concepts of Eucaryotic Transport Systems (2) I Modern concepts of eucaryotic cell transport systems. 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.

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**Molecular and Cellular Biology (MCB)**

Biosciences West Building, Room 308 (602) 621-7560

Professors Samuel Ward, Head; Vasken Aposhian, George T. Bowden (Radiation Oncology), Wayne R. Ferris, William J. Grimes (Biophysical Chemistry), Jon E. Hildenbrand (Anatomy), Richard B. Hallick (Biochemistry), John Hildebrand (Arizona Research Laboratory), Konrad Keck, Neil H. Mendelson, David W. Mount, James W. O'Leary (Environmental Microbiology), Richard B. Hallick (Biochemistry), John

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**510. Plant Molecular Biology (3) II 1990-91** (Identical with Bioc. 510)

**512. Radiosotopes in Biology (3) II 1990-91** Advanced techniques in the application of radioactive tracers to problems of molecular biology, genetics, biochemistry, and related fields. P, 427 or 527. (Identical with Bioc. 512)

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**528R. Advanced Microbial Genetics (3) II 1990-91** 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, 181, 328, Ecol. 320 or 321. [Identical with Ecol. 528R, Gene. 528R, and Micr. 528R]

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**534. Insect Neurobiology (3) II** Introduction to the nervous systems of insects, the neurological basis of circadian rhythms, and the use of insects as model systems. P, 427 or 527. (Identical with Enzo. 534)

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Music (MUS/MUSI)

Music Building, Room 109
(602) 621-7023


Assistant Professors Angela Cofer, William Dietz, Patrick Neher, Gary B. Wilson, Rex A. Woods.

The school offers a program leading to the Master of Music degree with majors in composition, music education, musicology, music theory, and performance. The school also offers a program leading to the Doctor of Musical Arts degree with majors in composition, conducting, and performance. With the doctoral performance major, concentrations are available in bassoon, cello, clarinet, flute, horn, oboe, organ, percussion, piano, ophion, string bass, trombone, trumpet, viola, violin, and voice. The school also offers programs leading to the Doctor of Philosophy degree with majors in music theory or music education. All candidates for admission to the Ph.D. program with a major in music theory will show evidence of satisfactory competencies in their fields of concentration. There are two minors, one in music with a minor in piano, 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. Applicants for the Ph.D. program in music education will be required to furnish evidence of at least three years of successful teaching or administrative experience in the field of music whether in the public schools or at the college level. Additional details concerning the doctoral program in music education are available from the Director of Graduate Studies in Music. For further information concerning these degrees see Requirements for Master's Degrees/Master of Music and Requirements for Doctor's Degrees/Director of Musical Arts and Doctor of Philosophy elsewhere in this catalog.

Applicants are required to audition by personal appointment. Applicants for the Master's degree must take placement tests in music theory and in music history/literature. Doctoral students are not auditioned for the 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.

510a-510b. Pedagogy (2-2) Study, methods and repertory suitable for std teaching. Open to music majors in their second year.

518. Band Arranging (2) I 1989-90 C Detailed study of band instrumentation; ma works transcribed for concert band. P 42t. 520a-520b. Counterpoint (3-3) Practic study of the counterpoint of the 16th (in 520a) and 18th (in 520b) centuries.

521. Introduction to Graduate Music Theory (2) II 1989-90 C Introduction to graduate analysis with emphasis on the survey of analytical systems as applied to a number of stylistic periods. Bi cognitive and aural procedures will be integrated. Open to majors only.

522a-522b. Art Song Repertory (2-2) 1990-91 Class performance of representative selections from the standard repertory of German, Italian, French, Russian and English songs; problems of accompaniment, interpretation, and ensemble. Registration restricted to singers and pianists. Open to majors only.

524. History and Literature of Guitar (3) 1989-90 In-depth study of the evolution of the guitar, lute, and vihuela, including repertory, periods, and composers. Open to majors only.

525. History and Literature of the Winds (3) A research-oriented study of wind band history and literature from the Renaissance to the present.

526a-526b. Piano Literature (3-3) History and stylistic study of keyboard literature, instruments and performance practices. 58 Baroque through the 18th; 526a 526b: Mid-Romantic through the Contemporary periods. P. 285-P. 526a is not prerequisite to 526b.

530. Music in the Renaissance (3) II 1989 Vocal and instrumental genres from Duf through Palestrina. Open to majors only.

531. Music in the Baroque (3) I 1989-90 C The baroque-continuo; instrument and voice genres through the early Romantic period. B. Bach. Open to majors only.

532. Music in the Classical Period (3) 1990-91 CDT The Viennese classical tradition from its origins to Beethoven. Open to majors only.

533. Music of the Twentieth Century (3) 1990-91 CDT Contemporary idioms in music histories, styles, and techniques post-Romanticism to the present. Open to majors only.

534. Music in World Cultures (3) II CDT or view of newworld musics in selected world cultures.

535. Music in the Middle Ages (3) II 1990 Secular and sacred monody and polyphony Gregorian chant through Dunspeck.


537. Survey of Early Music (3) I S Intens survey of music history from Gregorian chant the late Baroque. Open to majors only.


551. Special Problems in Music Education (3) 1990-91 Research methodologies as they apply to musical behavior; emphasis on applying results of existing studies to practice and conducting original research.
Aesthetics of Music (3) I Exploration of problems of musical meanings, including a critical examination of what philosophers, musicologists, composers, and artists and others have contributed to comprehensive theory.

Advanced Conducting (3) [Rpt.] II Styles, instrumentation, and orchestral literature, as they pertain to the problems of the conductor; to the styles of all periods, with emphasis on the contemporary and modern.

Introduction to Graduate Study in Music (3) II Bibliographical materials; research techniques, training, and problems directed toward research in music. Required of all doctoral candidates in music. (Identical with 600.)

History of Speculative Theory (3) I 1969-70 Survey of speculative theory in electrical, classical Greeks to the present.

History of Music of the 18th and 19th Centuries (3-3) Intensive analysis of works by minor composers, techniques, and problems directed toward research in music. Required of all doctoral candidates in music. (Identical with 600.)

Theory Pedagogy (3) I 1990-91 Study of philosophies, procedures, techniques, and problems of music education in the public schools, with emphasis on contemporary educational theory and composition majors only.

Analysis of Contemporary Music (3) II Analysis of representative works of the century.

The Music of Bach (3) II 1990-91

The Music of Mozart (3) II 1989-90

Choral Literature and Techniques (3) I, II A research-oriented study of choral music from the Renaissance to the present, together with appropriate conducting techniques. Prerequisite to 621b.

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The interdepartmental Committee on Neuroscience offers a graduate program leading to the Doctor of Philosophy degree with a major in neuroscience, as well as a graduate minor in neuroscience. A Master of Science degree is offered only in rare instances when students who have already passed the M.S. evaluation requirement are unable to continue on the doctoral program. The committee comprises faculty members from several departments in the college: Arts and Sciences, Engineering, Business, and Economics, Medicine, Nursing, and Pharmacy, as well as the Arizona Research Laboratories. The members of the Committee on Neuroscience are the principal faculty of the graduate program and may serve as major advisors for students majoring in neuroscience. In addition, the committee fosters research and communication among the various interdepartmental faculty throughout the University. Research interests of the faculty range from molecular mechanisms of synaptic transmission to human neurological disorders. Research has a strong focus upon cognitive neuroscience, developmental neurobiology, human speech and hearing, insect neurobiology, neuroepitopes, neuropharmacology, and motor control. Information about the research interests of the faculty can be obtained from the program office.

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 students 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 related fields.

For the Master of Science degree a thesis is required of all students except those working in the energy systems engineering option.

515. Environmental Analysis of Energy Conversion (3) Engineering analysis, assessment, and resolution of energy-environment interaction, with consideration of power plant siting, emissions, thermal effects, and waste management.

517. Nuclear Energy and Power (3) Fundamentals of nuclear energy and radiation; nuclear engineering applications; the basic concepts of nuclear reactors and power systems. Design for nonmajors.

520. Nuclear Engineering Laboratory (3) Experimental techniques for determining various parameters for nuclear systems: experiments using the critical and subcritical reactors. P. 343 or 540.

530. Radiochemistry and Radiation Detection (3) Radiation detection and measurement, health physics, isotope application, activation analysis, and instrumentation. R. P. Chem. 4800 or Phys. 330. (Identical with Chem. 530)


534. Power Plant Engineering (3) Introduction to power production, power plant requirements for achieving desired electric energy, and the state of the art of the electric utility industry. P. CR, Math. 422a.


Industrial Energy Utilization and Management (3) II Analysis of effective energy utilization in various industries and applications. Course includes lectures, research, and an original paper. P, 567. (Identical with Ch.E. 667 and E.C.E. 667)

681a-681b. Analytical Methods of Transport Theory (3-3) 1989-90 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, Phys. 470b. (Identical with E.C.E. 685b)

687. Magnetic Confinement Controlled Fusion (3-3) II Theory and design of magnetic fusion systems, instabilities, transport and reactivity of fusion devices, applications to linear and magnetic fusion systems; Tokamaks and mirror machines. P, Phys. 415b, 470b. (Identical with E.C.E. 687b)

Nursing (NURS)

Nursing Building, Room 316

(602) 626-6154

Professors L. Claire Parsons, Dean, Agnes M. Aamodt (Emerita), Jan R. Alwood, Eleanor E. Baumgarten, Pearl P. Coulter (Emerita), Acta Sue Hinshaw, Margarita A. Kay, Beverly A. McLeod, Merle Misich, Arlene M. Pratt (Emerita), Gladys E. Erens (Emerita)

Associate Professors: Brenda A. Wirtanen, Sandra Feak, Gerber Rose, Mary E. Hazzard, Alice J. Longman, Lilan Lynch (Emerita), Betty J. McCracken (Emerita), Virginia Miller (Emerita), Carolyn McCaughey, Alice L. Noyes, Jesse V. Pergin, Linda R. Phillips, Lois E. Prosser (Emerita), Pamela Reed, Gayle A. Traver, Suzanne Van Ori, Joyce Veran, Mary Jane Wett, (Emerita), Mary O. Wolanski (Emerita)

Assistant Professors: Mary Alexander, Terry B. Allen, Sandra Feak, Gerber Rose, Mary E. Hazzard, Alice J. Longman, Lilan Lynch (Emerita), Betty J. McCracken (Emerita), Virginia Miller (Emerita), Carolyn McCaughey, Alice L. Noyes, Jesse V. Pergin, Linda R. Phillips, Lois E. Prosser (Emerita), Pamela Reed, Gayle A. Traver, Suzanne Van Ori, Joyce Veran, Mary Jane Wett, (Emerita), Mary O. Wolanski (Emerita)

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 those nurs- ing programs at the University of Arizona; (2) a current license to practice as a registered nurse in one of the states, (3) references attesting to professional competence, (4) evidence of satisfactory completion of a course in elementary statistics, (5) scores on the aptitude test of the Graduate Record Examination, (6) a statement indicating academic and professional goals as well as research interests, and (7) evidence of skills in physical assessment. Computer literacy recommended.

An automobile is essential since the clinical facilities are located throughout the Tucson area.

Degrees

Nursing Specialist: For information concerning this degree program see Requirements for Spec- ialist Degrees/Nursing Specialist elsewhere in this catalog.

Applicants to the graduate program must provide evidence of the completion of a bache- lor's degree or both bachelor's and master's degrees substantially equivalent to those nurs- ing programs at the University of Arizona. Admissions is based upon the applicant's meeting 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 at least 550 on the quantitative and verbal portions of the aptitude test. In addition, applicants must submit refer- ences attesting to their potential as graduate students. The major purpose of the program is the prepara- tion of the clinical nurse researcher. At the time of catalog editing, the require- ments for the Master of Science and Doctor of Philosophy degrees were under review. Consult the College of Nursing for current information.

The College of Nursing graduate program is planned for four years and 108 units of gradu- ate credit. Thirty-three units of credit are required for admission to doctoral standing. A student who elects to exit with a master's degree will complete 36 credits and 30 additional units. Students progressing directly through the doctoral program are not required to complete a master's thesis.


587. Poverty and Health (3) II Study of the relationship between poverty and health. Con- cepts and theories from anthropology, psychol- ogy and sociology will be used to analyze problems associated with poverty. Advanced degree credit available for non-Ph.D. majors only. P, six units of social science. (Identical with Anth. 587 and F.C.M. 587)

588. Clinical Anthropology (3) II Application of anthropologic principles to the evaluation of the actual practice of patient care, with emphasis on culture content of groups living in the greater Southwest. P, nine units of behavioral science. (Identical with Anth. 588)

589. Health of the Older Adult (3) I Current research of the aging process including physi- cal and mental alterations; emphasis on physi- ological changes. Consult college before enrolling. (Identical with Ger. 589)

590. Colloquium

a. Bilingual Health Communication (3) I (Identical with Anth. 559a, which is home.)

May be convened with 400-level course.

600a-600b. Nursing Theory and Practice (3-3) II S Maintenance, therapeutic and pre- vention nursing care of persons in various set- tings. Student elects practice in one area of nurs- ing: 600a (I) is selected for (1) child, (2) newborn, or (3) psychiatric-mental-health. 600b (II) is chosen for (1) community health, (2) gerontology, (3) medical-surgical.

601. Pathophysiologic Alterations (3) I, II The physiology alterations related to changes in physiological and psychological stresses on the body, with particular emphasis to alterations in perfusion, oxygenation, hydration, osmolality, temperature, and resis- tance to infection. P, 586 or 3 hours of 600 level physiology.

603. Public Health Science (3) I Health pro- motion and primary prevention in populations and neighborhoods. Epidemiology and policy- making issues in advanced public health nurs- ing. Nursing and public health theories syn- thesized. Open to majors only.
604. Developmental Concepts in Nursing (3) II Examination of concepts of development over the life span and their relationship to nursing phenomenon. Skills in testing and constructing, development of are explored and applied to nursing theory construction, development, research, and practice. Open to majors only.

605. Concepts in Medical Relations (3) II Examination of issues in providing care to families using theory and research from nursing and related fields. Concepts included will apply to the problems of coping, and family maturity. Open to majors only.

606. Social, Psychological Problems in Nursing (3) II Focus on concepts of stress and training strategies presented on health-related outcomes. Nursing research on addictions, depression, abuse and violence will be explored. Open to majors only.

607. Cross-Cultural Nursing (3) Focus on a synthesis of theories from nursing and related fields to explore cultural variations in response to actual or potential problems of health or illness. The methods for caring and treating culturally influenced responses will be examined. Open to majors only.

610. Exercise in Theory Construction. Laboratory is development strategies; provision for an actual or potential problems of health or ill-

633. Evaluation Process in Nursing (3) I Application of selected qualitative research from nursing and related fields. Concepts included will apply to the problems of coping, and family maturity. Open to majors only.

631. Clinical Phenomena: Theories and Research (3) I Theoretical and practical application of teaching-learning process in classroom and clinical settings. Principles of teaching, learning, instructional design, testing. Microteaching included. 2R, 3L. Open to majors only.

624. The Administrative Process (3) I Theoretical and practical application of curriculum development and process. Use of teaching-learning process. Preparation for nurse educator role. Directed practice teaching included. 1R, 6L. Open to majors only.

623. Clinical Agency Administration (3) I Practical application of administrative processes in a nursing care delivery setting. Focuses on the use of selected skills essential to effective administration. Open to majors only. P, 2R, 3L. Open to majors only.

624. The Administrative Process (3) I Theoretical and practical application of teaching-learning process in classroom and clinical settings. Principles of teaching, learning, instructional design, testing. Microteaching included. 2R, 3L. Open to majors only.

630. Methods in Nursing Research (3) I Critical thinking in selected processes, research methods in the nursing research process. Consideration is given to both qualitative and quantitative methods.

631. Critical Phenomena: Theories and Research (3) I S Theory and research surrounding conceptual models with emphasis on description of conceptual models.

632. Research Utilization I S Development and use of models and tools for facilitating the use of research in science-based nursing practice. 2R, 3L. P, 630.

633. Evaluation Process in Nursing (3) I Development and use of models and tools for assessing nursing processes, programs and performance of staff. Use of psychometric tools and psychometric tools are discussed. Evaluation of nursing principles and objectives are evaluated. Open to majors.

605. Testing Nursing Theory (3) I Logical testing of theories in practice; history of nursing theory development related to basic epistemology. A range of theories: alternative metatheoretical structures, clinical theory development strategies; provision for an exercise in theory construction. Laboratory is required. P, 6 units of clinical specialty of clinical selective, 3 units of advanced human physiology, 3 units of social science at an advanced level.

706. Middle Range Theory (3) I Introduction to ways of knowing, focus on middle range theories in nursing and related sciences. Emphasis on critique, elaboration and theory testing of middle range theory. Selected middle range theories are only. P, 705.

710. Quantitative Methods in Clinical Nursing Research (3) I Investigation of selected quantitative strategies appropriate to research in clinical nursing. P, 630, 724a-724b, 724c. Professional Role Development (1-1) I I Assist student socialization into the role of nurse scientist. Ethics of research, development, and dissemination of scholarly work through publication and presentation, balancing roles of scholar, educator, and clinician. Open to majors only. P, admission to Ph.D. program.

771. Qualitative Methods in Clinical Nursing Research (3) I Application of selected qualitative research methods from the social sciences to clinical nursing. P, 630.

775. Study of Social Influences (3) S In-depth examination of social forces affecting the health care system. Emphasis on confirmatory and exploratory analysis of social data. Open to majors only. P, 630.

779. Quantitative Nursing Research (3) I Provides knowledge necessary to deal with clinical nursing research numerical data sets. Emphasis on confirmatory and exploratory analysis of data. Open to majors only. P, 630.

520. Advanced Nutritional Science (1) Advanced physiology and biochemistry of nutrients with emphasis on present knowledge and current research topics in nutritional sciences. P, 360 or 462a.


541. *Therapeutic Nutrition (4) I II Therapeutic principles of nutrient acquisition and utilization including modified dietetic principles for disease and/or deficiency states; factors important in client/patient care, rehabilitation, and education. P, 406.

542. Perspective in Geriatrics Laboratory (1) I (Identical with Ph. Pr. 547)

548. Nutrition in Sport and Exercise (3) S (Identical with Ex.S.S. 548)

549. Advanced Food Science (3) I Fe safety evaluation, microbiology of pathogen and beneficial organisms, chemistry, engineering, processing; analytical chemistry; laboratory, one year of biochemistry with Gero. 538) McCaughey.

559. *Sensory Evaluation of Food (3) 1989-90 Fundamentals of taste, odor, color; a review of current research; consumer behavior/ teaching, and methodol

569. Postharvest Physiology (3) S 1989 (Identical with Ph. S. 569)

567. Food Processing (3-3) 1989-90 Refrigeration, freezing, dehydration, fermentation and pickling, irradiation and addition of chemicals, as they apply to food preservation and processing, retention.
672. Food Safety (2) I 1989-90 Significance and control of foodborne hazards associated with pathogenic microorganisms, microbial toxins, nutrients, and other environmental contaminants. P. 471, Chem. 241b. (Identical with Micr. 672) Gerba

693. Internship

a. Dietetic Internship, ADA Accredited (1-6) [Rpt./2] I II Field trips. Begins Mid-August and continues for 46 weeks. Consult dept. before enrolling. Open to majors only. P. course work equivalent to Amer. Dietetic Association Plan IV.

696. Seminar

b. Nutrition (1) [Rpt./6 units] I II (Identical with Nu.Sc. 696b)
c. Food Science (1) [Rpt./6 units] I II

Nutritional Sciences (NUSC)
Shantz Building, Room 309 (602) 621-5630

Committee on Nutritional Sciences (Graduate)

Professors Donald J. McNamara (Nutrition and Food Science), Chairperson, David S. Alberts (Internal Medicine), James W. Berry (Nutrition and Food Science), Michael H. Brown (Animal Sciences), James Blanchard (Pharmacological Sciences), Herbert E. Carter (Emeritus, Biochemistry), Milos Chvapil (Surgery), David L. Earnest (Internal Medicine), Charles Gerba (Microbiology and Immunology), Gail G. Harrison (Family and Community Medicine; Pediatrics; Nutrition and Food Science), T. Huber (Animal Sciences), Wayburn S. Jeter (Microbiology and Immunology), Mary Ann Kight (Nutrition and Food Science), Otsak Koldovsky (Pediatrics), K. Lei (Nutrition and Food Sciences), Timothy Lohnan (Exercise and Sport Science), John A. Marchese (Animal Sciences, Nutrition and Food Science), Thomas Moon (Family and Community Medicine), Helen Olson (Microbiology and Immunology), Bobb L. Reid (Animal Sciences, Nutrition and Food Science), Richard W. Rice (Animal Sciences), Frank D. Rollins (Animal Sciences), Frank M. Whiting (Animal Sciences), W. A. Schurg (Animal Sciences), K. Ritenbaugh (Family and Community Medicine; Pediatrics), Roger P. Angel (Steward Observatory), B. Roy Shantz (Pediatrics), W. A. Schurg (Animal Sciences), K. Ritenbaugh (Family and Community Medicine; Pediatrics).

Degree

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. Students must meet the minimum requirements established for the master's degree in their options, plus additional requirements specified by the student's graduate advisory committee, before obtaining the Ph.D. A maximum of ten units of individual studies (596, 699, 900) and seminar (596, 696) credits will be counted toward requirements for the degree.

A minor may be chosen from a variety of areas including biochemistry, physiological sciences, molecular and cellular biology, ecology and evolutionary biology, food science, anthropology, pharmacology, and chemistry. Programs for both degrees will emphasize courses from the following listing.

Related Courses

605. Methods in Nutritional Research (3) I Survey of experimental approaches to nutrition research in the areas of food science, animal nutrition, nutritional biochemistry and human nutrition.

696. Seminar

b. Nutrition (1) I II (Identical with N.F.S. 696b, which is home)

Occupational Safety and Health (See Health-Related Professions)

Operations Management (See Management Information Systems)

Optical Sciences (OPTI)
Optical Sciences Center, Room 401 (602) 621-4111

Committee on Optical Sciences (Graduate)

Professors Robert R. Shannon, Chairperson, J. Roger P. Angel (Steward Observatory), George H. Atkinson (Chemistry), Harrison H. Barrett (Radiology), Peter H. Bartels (Pathology), James J. Burke, Charles M. Falco (Physics), Peter A. Franken (Physics), B. Roy
Frieden, Kenneth F. Galloway (Electrical and Computer Engineering), Jack D. Gaskill (Electrical and Computer Engineering), Hyatt M. Gibbs, Arthur F. Gmitro (Radiology), Stephen B. Goldberg, Christian Gromoll (Mechanical Engineering), Murray Gourley (Mechanics), Willis E. Lamb, Jr. (Physics), H. Angus Macleod, Arvind S. Marathay, Aden B. Meinel (Emeritus), Pierre Meystre, Ralph M. Richardson (Mechanical Engineering and Mechanics), Murray Sargent Ill, D. R. Sarad, Bernhard O. Seraphin, Roland V. Shack, Richard L. Shoemaker, Philip N. Slater (Research Associate), Donald N. Stavroudis (Emeritus), George I.A. Stegeman, A. Francis Turner (Emeritus), Donald R. Uhlman (Materials Science), William H. Wing (Physics), William L. Wolfe, Jr. (Radiology), James C. Wyant

Associate Professor William J. Dallas (Radiology), Eustace L. Dereniak, Ursula J. Gibson, Stephan W. Koch (Physics), George N. Lawrence, Masud Mansuripur, Nasser Peyghambarian, Robert R. Schowengerdt (Electrical and Computer Engineering, Arid Lands), Robin N. Sinha (Electrical and Computer Engineering) Assistant Professors Chris L. Koliopoulos, Raymond K. Kostik (Electrical and Computer Engineering)

The Committee on Optical Sciences offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in optical sciences. Areas in which research is currently being conducted include electro-optics, image formation, image processing, laser physics, materials, medical optics, non-linear optics, optical bistability, optical design, optical fabrication and testing, optical properties of materials, pattern recognition, quantum optics, random processes, spectroscopy, surface physics, and thin-film technology. Interdisciplinary programs in progress involve the departments of Astronomy, Chemistry, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Physics, and Radiology, as well as the Arizona Research Laboratory, the Optical Circuitry Cooperative and the Data Optical Storage Center.

Applicants should hold a bachelor's degree in engineering, mathematics, or physics. In addition, the application materials submitted to the Graduate College, applicants must submit to the Associate Director, Academic Affairs, Optical Sciences Center, University of Arizona, Tucson, the following documents: one complete set of transcripts, scores on the aptitude and subject (engineering, mathematics, or physics) tests of the Graduate Record Examination, and at least two letters of recommendation. Normally, students are only admitted to begin their studies in optical sciences as well as those majoring in other disciplines, majoring 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 transfer of work in transferred course work. No more than six of these units may be crosslisted with the student's major department (if different than optical sciences).

501. Electromagnetic Foundations of Optics (3) I Gauss's 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, Math 100B.

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.

505L. Interference and Interferometry (3) I Wave equations; energy flow; polarization; interference; coherence; interferometers; optical testing; heterodyne interferometry; holography; speckle interferometry. P, 501, 502.

505L. Interference and Interferometry Laboratory (1) I Laboratory in support of 505. P, CR, 503.

504. Introduction to Quantum Optics (3) I Quantization of radiation. Planck's law; Einstein's law; with matter; dipole moments; line broadening; quantization of radiation fields; spontaneous emission; stimulated emission; lasers. P, 501, Physics 505.

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 Laboratory in support of 505. P, CR, 503.

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, semiconductors, magnetic and insulating materials; defects; surface states; surface recombination. 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; imag and non-imaging detectors. P, 503, 503L.

513. Optical Testing (3) I 1989-90 Metrology: components; aspheric surface testing; astigmatism; alignment of systems; system evaluation. P, 505.


1989-90 Thermal Radiation Laboratory (3) I 1990-91 Advanced optical materials; geometrical image formation; diffraction, spread, and transfer functions; random wavefront perturbations; system effects; image processing. P, 505.

517. Lens Design (4) I Fundamentals of optical system layout and design; exact and partial ray tracing; aberration theory; chromatic and spherical aberration. P, 505.

524. Optical Data Processing (3) I 1989: 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 1990-91 Historical background: the Gabor hologram; the hologram model of interaction of radiation with matter; Fresnel zone plates, and reflection holograms; practical hologram limitations. P, 505.


531. Image Processing Laboratory (3) I (Identical with E.C.E. 531)

532. Pattern Recognition and Computer Vision (3) II I (Identical with E.C.E. 532)

533. Image Processing: Devices, System Applications (3) I 1989-90 I (Identical with E.C.E. 553)

534.* Electrical and Optical Properties of Semiconducting Materials (3) I I (Identical with M.S.E. 534)


539. Estimation Methods in Optics (1) 1989-90 Bayesian MAP and MMSE estimate maximum entropy estimates, restoration images and spectra, phase retrieval, medical imaging, and Applications I 1989-90 (Identical with E.C.E. 539)

540a-540b.* Atomic and Molecular Spectroscopy for Experimentalists (3-3) I (Identical with Phys. 540a-540b)

541. Introduction to Lasers (3) I Laser their properties of lasers; stimulated emission; laser pulse theory; gain saturation and rate equation; optical resonators; survey of laser theory and beam character. P, Phys. 105.


543. Laser Physics (3) I Density matrix formalism of interaction with matter; semiclassical laser theory; single and multimode scalar fields; moving atoms; ring a Zeeman lasers; pressure effects. P, 504 (identical with Phys. 543).

544. Advanced Electrodynamics (3) 1989-90 Normal modes of matter; macroscopic electrodynamics; optical activity; crystal optics; magnetic properties of metals; magnetooptics; bulk acous; optics; scattering. P, 501.


550. Fundamentals of Remote Sensing (6) I (Identical with Phys. and methodology of remote sensor radiometry; data collection systems; pho
Detectors, electromagnetic radiation; X-ray; gamma ray; detector; semiconductor; fiber waveguide; design methods; optical phase conjugation; optical fiber; transfer efficiency; display; data processing; coherence; photographic record of optical image. P, 509, CR, 566.

ii. Optical Detectors (3) 1990-91 Photodetectors; semiconductors; noise and quantum theory; silicon devices; materials limitations on the detectivity of detectors; photomultipliers, thermal detectors. P, 509, CR, 566.

iii. Photographic Recording Processes (3) 1989-90 The principles of obtaining a photographic record of an optical image.


v. Fiber Optics Laboratory (3) 1990-91 Characteristics; fiber preparation; single and multimode fibers; sources and coupling; nonlinear interactions; multiplexing techniques; fiber optic sensors. P, 503.

vi. Seminar


vii. Colloquium

a. Current Subjects in Optical Sciences (1) I

viii. Workshop

a. Optical Shop Practices (3) I 1R, 6L. P, 513, 513L.

ix. Advanced Radiological Imaging (3) 0-91 Signal processing; image reconstruction; theory of stochastic processes to imaging systems using x-rays and gamma rays. P, 534.

x. Quantum Optics (3) 1990-91 Quantum theory of light; quantum coherence; spontaneous emission; Dicke superradiance; optical intensity and coherence; quantum theory of the atom; superconductivity and Josephson radiation. P, 543, (Identical with Phys. 643)

xi. Atmospheric Optics and Radiation (3-3) 1990-91 (Identical with Atmo. 656a-656b)

xii. Microcomputer Interfacing in the Optics Laboratory (3) I Design and construction of interfaces between microcomputers and 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, 550, CR, 551, C.S.C. 122 or E.C.E. 171.

xiii. Seminar


xiv. Colloquium

a. Current Subjects in Optical Sciences (1) I

xv. Workshop

a. Optical Shop Practices (3) I 1R, 6L. P, 513, 513L.

xvi. Advanced Radiological Imaging (3) 0-91 Signal processing; image reconstruction; theory of stochastic processes to imaging systems using x-rays and gamma rays. P, 534.

xvii. Quantum Optics (3) 1990-91 Quantum theory of light; quantum coherence; spontaneous emission; Dicke superradiance; optical intensity and coherence; quantum theory of the atom; superconductivity and Josephson radiation. P, 543, (Identical with Phys. 643)

xviii. Atmospheric Optics and Radiation (3-3) 1990-91 (Identical with Atmo. 656a-656b)

xix. Microcomputer Interfacing in the Optics Laboratory (3) I Design and construction of interfaces between microcomputers and 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, 550, CR, 551, C.S.C. 122 or E.C.E. 171.

xx. Seminar


xxi. Colloquium

a. Current Subjects in Optical Sciences (1) I

xxii. Workshop

a. Optical Shop Practices (3) I 1R, 6L. P, 513, 513L.
576. Modern Chinese History (3) Historical survey of the period since 1911 which examines the revolutionary developments shaping contemporary China. (Identical with Hist. 576)

582. History of China (3) Formation of ancient Chinese society; organization of families and clans; social stratification, mobility, conflict, and control in traditional China; and transformations from traditional to modern society. (Identical with Hist. 582)

595. Colloquium
   a. China (3) [Rpt.] I
   i. Confucianism: The Classical Period (3) (Identical with Hist. 595i, which is home.)
   j. *Confucianism: The Neo-Confucian Tradition (3) (Identical with Hist. 595j, which is home.)
   r. *Revolution in Chinese History (3) II (Identical with Hist. 595r)

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

India-Pakistan

545. Hindu Mysticism (3) II Introduction to the concepts and practices of Hindu mysticism, including yoga techniques, rites, symbols, and myths. (Identical with Reli. 545)

552. Hindu Mythology and Literature (3) I Introduction to the literary works with ancient Sanskrit myths. Selections from the Vedas, epics, Puranas and other classics in English translation.

570. Religious History of India (3) (Identical with Hist. 570)

572. History of Medieval India (3) I 1989-90 (Identical with Hist. 572)

573. History of Modern India and Pakistan: 1750-Present (3) II 1989-90 (Identical with Hist. 573)

585. Social Organization of India and Pakistan (3) I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with Anth. 585)

586. Political Systems of India and Pakistan (3) II Survey of post-independence political developments in Pakistan and India. (Identical with Pol. 586)

Japan

Prior to registering in any Japanese language course other than 102a, the student must demonstrate the minimum knowledge of Japanese recommended by the instructor.

502. Literary Japanese (3) Introduction to the varieties of writing styles used from the 8th century to modern times, including Sino-Japanese, documentary, epistolary and purely literary styles.

511a-511b.* Modern Japanese Grammar (3-3) Introduction to Modern Japanese grammar, morphology, syntax, semantics, and pragmatics. (Identical with Ling. 511a-511b)

512a-512b.* Advanced Japanese (5-5) [Rpt.] CDT Reading from modern scholarship, fiction, and essays, with attention to grammatical analysis.

574a-574b-574c.* History of Japan (3-3-3) (Identical with Hist. 574a-574b-574c)

595. Colloquium
   b. *Japan (3) [Rpt.] /2 II

596. Seminar
   f. Japanese History (3) [Rpt.] I II

Judaic Studies

501. Ancient Mesopotamia (3) I (Identical with Anth. 501)


530. *Prophecy in Ancient Israel (3) II Nature and function of prophecy and its ancient Near-Eastern analogues, including intensive study of several major Biblical prophets.

553. *Advanced Hebrew (3) [Rpt.] Advanced Biblical, Rabbinic, and/or modern Hebrew language and literature. P. 403b, 409b or 509b.

595. Colloquium
   g. Judaic Studies (3) [Rpt./4] Consult department before enrolling.

596. Seminar
   w. *Sex Roles in the Bible (3) II

Middle East

514a-514b.* Advanced Arabic (3-3) Continuation of 404b, with emphasis on oral and written comprehension and expression. P. 404b, 514a is not prerequisite to 514b.

515a-515b.* Advanced Persian (4-4) CDT Persian, with the objective of preparing the student for independent research. 515a: Contem- porary prose. 515b: Poetry and prose. P. two years of Persian. 515a is not prerequisite to 515b, and will not replace Conversational Levantine Arabic (3-3) 1990-91 Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and the consolidation of the comprehension. P. 104a.

525a-525b.* Conversational Gulf Arabic (3-3) Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and comprehension. P. 104a.

526. *Introduction to Arabic Linguistics (3) II History and structure of the Arabic language in its various forms. P. 104b, Ling. 101. (Identical with Ling. 526)

534. *Islamic Thought (3) II Traditional ideological systems of Islamic countries and their evolutionary transformations.

537a-537b. Readings in Akkadian (3-3) (Identical with Anth. 537a-537b)

539a-539b.* Egyptian Arabic (3-3) Introduction to the Cairene dialect. Phonology, common vocabulary and grammar.

542. *Transformation of Agrarian Societies in the Middle East (3) II Dynamics, processes, and implications of rural change in the Middle East; focus on changes in peasant communities, nomadic pastoralists, rural-urban relations, and planned change. (Identical with Anth. 542, Pol. 542, A.Ec. 542)

548.* Arabic Literature in English (3) Historical survey of Arabic literature of the Middle East and Mediterranean world, with readings in English translations.

549.* Persian Literature in English (3) II Historical survey of Persian literary traditions, with readings in English translations.

557.* Prehistoric Mesopotamia (3) I (Identical with Anth. 557)

567.* Population and Development in the Middle East (3) I Review of theories and research in population, resources and socio-economic development, with emphasis on determinants and consequences of population growth and migration in contemporary Middle East. (Identical with A.Ec. 567 and Pol. 567)

577a-577b. *History of the Middle East (3-3) History of civilization in the Middle East from the rise of the Sumerians to 1500 B.C., and the rise of the Arab dominace. 577b: Period of Turkish dominance. 577a is not prerequisite to 577b. (Identical with Hist. 577a-577b)

578.* Modern History of the Middle East (3) I Near and Middle Eastern history since the late 18th century, with special emphasis on Egypt and areas to the east. (Identical with Hist. 578)

581a-581b.* Archaeology of Syria-Palestine in the Bronze and Iron Ages (3-3) Survey of the Bronze and Iron Age cultures of Syria Palestine, ca. 3500-500 B.C., with emphasis on the use of archaeological materials in historical reconstruction. P, consult department before enrolling.

584a-584b.* Akkadian Linguistics (3) (Identical with Anth. 584a-584b)

595. Colloquium
d. Middle East (3) [Rpt.] I II  f. Ancient Near East (3) [Rpt./4] Consult department before enrolling.

n. Modern Arabic (3) [Rpt./1] II  o. *Classical Arabic Prose (3) [Rpt.] II t. years of Arabic.

z. *Readings in Classical Arabic Poetry (3) P. three years of Arabic for non-native speakers of Arabic.

*May be convened with 400-level course.

596. Seminar
   m. Middle East: Topics in History and Civilization (3) [Rpt.] II
   q. *Middle Eastern Archaeology (3) [Rpt./1] II (Identical with Anth. 596q)

Paleontology

(See Geosciences)

Performance

(See Music)

Persian

(See Oriental Studies)

Personnel Management

(See Management and Policy)

Pharmaceutical Sciences (PHSC)

Pharmacy Building, Room 408
(602) 626-4531


The Department of Pharmaceutical Sciences includes the academic disciplines of pharmaceutical chemistry, biopharmaceutics, pharmacokinetics, pharmaceutics, and pharmacognosy. It offers programs leading to Master of Science and Doctor of Philosophy degrees with a major in pharmaceutical sciences. Concentrations within the major include pharmaceutical chemistry, biopharmaceuticals, pharmacokinetics, pharmaceutics, and pharmacognosy.

A bachelor's degree in pharmacy, chemical or biological science is prerequisite to admission to the graduate program. Admission to the doctoral programs usually requires, in addition to appropriate preparation in mathematics, a two-year course in upper division general pharmacology, 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 field for doctoral students include biology, chemistry, mathematics, microbiology, nutrition, pharmacology, physiology, zoology, or pharmacognosy. Suitable concentrations different from the principal concentration selected by the student.
Pharmacology (PHCL)

Pharmacy Building, Room 236
(602) 626-7218

(Department, College of Medicine)

Professors Thomas F. Burks, Head, David S. Alberts (Internal Medicine), H. Vasken Aposhian (Molecular and Cellular Biology), Klaus Brendel, Rubin Bressler (Internal Medicine), Burnell R. Brown (Anesthesiology), Ryan J. Huether, David G. Johnson (Internal Medicine), Eugene Morkin (Internal Medicine), John D. Palmer, Charles W. Putnam (Surgery), William R. Roeseke (Internal Medicine), I. Glenn Sipes (Pharmacology and Toxicology), Henry I. Yamamura

Associate Professors Dean E. Carter (Pharmacology and Toxicology), Kenneth A. Conrad (Molecular and Cellular Biology), Timothy C. Fagan (Internal Medicine) Edward D. French, A. Jay Gandolfi (Anesthesiology), Marilyn J. Halonen, David L. Kreu en, Thomas J. Lindell, Frank E.

Assistant Professor Laurel A. Fisher

The Department of Pharmacology in the College of Medicine cooperates with the Department of Pharmaceutical Science and Toxicology in the College of Pharmacy, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science degree in the two fields. The mandatory courses in these fields include the study of the basis of chemical structure, the structure-activity relationships of medicinal agents; principles of drug action, the diagnosis, prevention, cure, and control of disease; a broad base of modern biology from the molecular to the clinical level; and pharmacologic and toxicologic techniques. P, 302b, 361b, 501, 511b, 561b. (Identical with Tox. 511)

501. The Pharmacological Basis of Therapeutics (6) II Actions of chemical agents upon living material at all levels of organization, with emphasis on mechanisms of action of prototype drugs; foundation for a rational approach to human therapeutics and toxicology. P, Psio. 601, Bioc. 501. (Identical with Tox. 501)

520. Clinical Pharmacology (2) I Effects of drugs on natural history of disease; drug-drug interactions; drug testing designs; drug abuse; drug literature evaluation; aspects of clinical toxicology. P. 501.

550. Drug Disposition and Metabolism (2) I Principles of distribution and excretion of drugs, with emphasis on mechanisms of drug disposition and pharmacokinetics. P, Bioc. 501, Tox. 602a. (Identical with Tox. 550)

551. Molecular Pharmacology of Pharmacological Agents (2) 1989-90 Molecular mechanism of drugs and toxins at the cellular and subcellular levels, including effects on control mechanisms, cell-cell interactions, organelles, and nucleic acid and protein synthesis. P, 501, 550, 561b, Bioc. 501. (Identical with Tox. 551)


561a-561b. Introduction to Pharmacological and Toxicological Literature (1-1) Designed to broaden the background of students in pharmacology and toxicology, and to improve scientific communication skills. P, 501. (Identical with Psio. 561b)

574. Environmental Toxicology (3) I (Identical with Tox. 574)

582. Immunotoxicology (2) I (Identical with Tox. 582)

583b. 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 pharmacologic and toxicologic techniques. P, CR, 501, Bioc. 565, Psio. 601.

601. Analytical Instrumentation and Techniques (4) II (Identical with Psio. 663)

602a-602b. Biotoxicochemistry (3-1) (Identical with Tox. 602a-602b)

653. Neuropharmacology (3-4) II (Identical with 651)

695. Colloquium

a. Cellular/Molecular Pharmacology (1-3) [Rpt./4 units] I II P, Bioc. 426a-426b; 568a-568b and/or Pcl. 551.

800. Research (1-6)

801. The Pharmacological Basis of Therapeutics (6) II


891. Preceptorship a. Pharmacology (3-12) [Rpt./12 units]

Pharmacology and Toxicology (PCOL/TOX)

Pharmacy Building, Room 236
(602) 626-2823

(Department, College of Pharmacy)

Professors I. Glenn Sipes, Head, Dean E. Carter, Lincoln Chin, J. Wesley Clayton, Paul F. Consore, Wayburn S. Jeter, Albert L. Picchioni, Findlay E. Russell, Theodore Tong (Pharmacy Practice)

Associate Professors G. Timothy Bowden (Radiation/Oncology), A. Jay Gandolfi (Anesthesiology), James R. Halpert, Hugh E. Laird, II, David L. Nelson

Assistant Professors Cliff Crutchfield (Family and Community Medicine), William S. Dalton (Internal Medicine), Robert T. Dorr (Internal Medicine), Daniel C. Leibler, John Sullivan (Emergency Medicine and Pharmacology)

Pharmacology is the science concerned with all aspects of the actions of drugs and other chemicals on living systems. Its primary aim is the discovery of chemical mechanisms by which cellular and molecular functions are regulated for the purpose of understanding how
existing drugs act and to develop new drugs for treatment of diseases. The broad scope of interests of pharmacology ranges from the study of intermolecular reactions of chemical constituents to drugs to the harmful effects of chemicals in our environment on entire populations. Toxology 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.

The broad scope of interests in toxicology ranges from determining the mechanisms by which chemicals produce adverse biological effects to identification, and quantification of hazards resulting from occupational and/or environmental exposure to chemicals. Industrial hygiene is the applied science concerned with the recognition, evaluation, and control of chemical and physical agents that can affect health status in occupational and environmental settings. An industrial hygiene concentration is offered within the Master of Science toxicology program. The concentration prepares students for professional practice in a diverse range of both private and public sector organizations.

A Doctor of Philosophy degree in this discipline is awarded through the Graduate Program in Pharmacology and Toxicology.

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 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.

Pharmacology (PCOL)

561a-561b. Introduction to Pharmacological and Therapeutical Literature (1) (Identical with Phcl. 561a-561b)

571a-571b.* Fundamentals of Pharmacology (4-4) Comprehensive study of the biochemical, physiological, and therapeutic effects of drugs, including mechanisms of drug action and drug toxicity, and drug literature evaluation. 3R, 3L, P, Anat. 401, Bioc. 460, Piso. 480, 481; CR, Ph.Pr. 475a-475b and Ph.Sc. 437a-437b. (Identical with Tox. 571a-571b)

572. Applied Pharmacology (3) II Pharmacodynamics, pharmacology, and adverse effects of common abused drugs, with emphasis on clinical applications. Not available for elective credit in the College of Pharmacy or graduate credit in pharmacology-toxicology doctoral programs. P, Ecol. 159b.

574. Clinical Toxicology (2) I Prevention, characteristics, diagnosis and rational management of diseases caused by drug overdose, toxic household products, poisonous plants, venomous animals, environmental and industrial toxicants. P, 472 or 471b, Ph.Sc. 407. (Identical with Tox. 574)

596. Seminar

a. Advanced Graduate Research (1-3) [Rpt.][3] I (Identical with Phcl. 596a, 596b, which is home)

653. Neuropharmacology (3-4) II Role of various neurochemicals in the peripheral and central nervous systems and the effects of drugs on the nervous system, including their actions at receptors and their influence on synthesis, storage, and release of neurotransmitters. P, Phcl. 501 or Pcol. 471b, 561a, 596. (Identical with Phcl. 653 and Tox. 653a)

695. Colloquium

a. Research Conference (1-4) [Rpt.] I

815. Pharmacy Subspecialty

a. Research Conference (1-3) 30L, P or CR, 10 units of 810. (Identical with Ph.Pr. 8151, which is home.)

Toxicology

The Department of Pharmacology and Toxicology in the College of Pharmacy offers a curriculum leading to the Master of Science degree with a major in toxicology. Prerequisite to admission is the completion of a bachelor's degree including one year each of analytical chemistry, biological science, and organic chemistry and a semester of instrumental analysis. Two letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Required courses for the graduate program are Toxicology (TOX) 471a, 471b, or 572a, 572b (or 562a, 562b) and 571a-571b (or Phcl. 501), 574, 596a, 596b, 601, and 602a-602b. A thesis is required.

Industrial Hygiene

Admission requirements for the industrial hygiene concentration are identical to those for the Master of Science degree in toxicology. Required courses for the industrial hygiene concentration are 554, 565, 580, 581, 586, 587, 596a, and 596b. A summer internship is recommended, and a thesis is required.

Toxicology (TOX)

501. The Pharmacological Basis of Therapeutics (6) II (Identical with Phcl. 501)

505. Insecticide Toxicology (3) II 1989-90 (Identical with Ento. 505)

510.* Physical Exposures (3) II (Identical with O.S.H. 510)

523R.* General Pathology (3) II 1990-91 (Identical with V.S.C. 523R)

523L.* General Pathology Laboratory (1) II 1990-91 (Identical with V.S.C. 523L)

550. Drug Disposition and Metabolism (2) II (Identical with Phcl. 550)

551. Molecular Biology of Pharmaceutical Agents (3) II (Identical with Phcl. 551)

554. Industrial Toxicology and Chemical Exposures (2-4) I Principles of toxicology related to industry; dose response; mechanisms of toxicity; hazard evaluation principles; toxicology of major classes of industrial compounds. P, 6 units each of biological science and organic chemistry.

562a-562b.* Biochemistry (4-3) (Identical with Bioc. 562a-562b)

563a-563b.* Human Physiology Laboratory (1) I (Identical with Ecol. 563a-563b)

564a-564b.* Human Physiology (3-3) (Identical with Ecol. 564a-564b)

565. Statistics for the Medical Sciences (4) I (Identical with Phcl. 565)

571a-571b.* Fundamentals of Pharmacology (4-4) (Identical with Pcol. 571a-571b)

574. Clinical Toxicology (2) I (Identical with Phcl. 574a, 574b)

576. Environmental Toxicology (3) I Toxicity of natural toxins and of agricultural and industrial chemicals, with emphasis on air and water pollutants and their impact in environmental issues. P, 6 units of biology and organic chemistry; Chem. 325, 326. (Identical with Ento. 576 and Phcl. 576)

580.* Human Physiology (4) II (Identical with Psio. 580)

581. Industrial Ventilation (3) II 1989-90 Design and evaluation of industrial ventilation systems. Emphasis is on level evaluation of industrial contaminants. Five laboratory exercises and course design project. 3R, 1L.

582. Immunotoxicology (2) I Broad overview of the immune system, with emphasis on how chemicals affect the immune system (immunomodulation) and the role of the immune system in chemical-induced tissue injury/repair responses. P, 602a-602b, Micr. 418, 567. (Identical with Micr. 582 and Phcl. 582)

586.* Fundamentals of Industrial Hygiene I I (Identical with O.S.H. 586)

586L.* Advanced Toxicological Hygiene and Safety (3) II (Identical with O.S.H. 587)

596. Seminar

a. Advanced Toxicology (1-2) [Rpt.] I

b. Current Concepts in Toxicology (1) I

601. Analytical Instrumentation and Techniques (4) I Lecture and laboratory in the qualitative and quantitative determination of toxic substances in the environment and body fluids. Modern instrumental techniques will be employed whenever appropriate. Lecture may be taken separately by non-majors. 2R, 8L. Coreq. 600a, I (Identical with Phcl. 602a-602b)

602a-602b. Biotoxology (3-1) 602a: I Lecture. Mechanisms of organ directed toxicities in animals. Chemical carcinogenesis, teratogenesis and mutagenesis as a basis for two semesters of ecology. 602b: II Laboratory. Proper use of animals in toxicology and pharmacology research; focuses on organ specific toxicities. (Identical with Phcl. 602a-602b)

610. Topics in Advanced Toxicology (1-3) I Current developments in toxicology including chemical carcinogenesis, mutagenesis, teratogenesis, behavioral toxicology, inhalation toxicology; toxicokinetics; metabolism as environmental toxicology. P, 471b, 474.

653. Neuropharmacology (3-4) II (Identical with Pcol. 653)

Pharmacology and Toxicology

Committee on Pharmacology and Toxicology (Graduate)

Professors I. Glenn Sipes, Chairperson, Kla Brendel, Thomas F. Burks
Associate Professors Thomas P. Davis, Jane R. Haybart, David L. Kreulen, Hugh E. Laird, II, David L. Nelson

The Department of Pharmacology in the College of Medicine and the Department of Pharmacology and Toxicology in the College of Pharmacy cooperate, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science with a major in pharmacology and the Doctor of Philosophy with a major in pharmacology as a postgraduate concentration within the Master of Science in Toxicology. Admission is the completion of a bachelor's degree in 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 Toxicology (TOX) 471a, 471b, or 572a, 572b (or 562a, 562b) and 571a-571b (or Phcl. 501), 574, 596a, 596b, 601, and 602a-602b. A thesis is required.
Research (3-3) 1990-91 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.


Note: 803a-e are six-week courses.


Note: 803a-e are six-week courses.

815. Pharmacy Subspecialty a. Hematology/Oncology (3-10) I S I S, or CR, 10 units of 810. b. Cardiology (3-10) I S I S, or CR, 10 units of 810. c. Pulmonary (3-10) I S I S, or CR, 10 units of 810. d. Endocrine (3-10) I S I S, or CR, 10 units of 810. e. GI/Renal (3-10) I S I S, or CR, 10 units of 810. f. Obst/Gyn/Neonatal (3-10) I S I S, or CR, 10 units of 810. g. Infectious Disease (3-10) I S I S, or CR, 10 units of 810. h. Rheumatology (3-10) I S I S, or CR, 10 units of 810. i. Dermatology (3-10) I S I S, or CR, 10 units of 810. j. Poison Information/Toxicology (3-10) I S I S, or CR, 10 units of 810. k. Administrative (3-10) I S I S 15-30L, P, or CR, 10 units of 810.

Note: 815a-i are six-week courses.

896. Seminar a. Pharmacy Practice (1) II b. Pharmacy Administration (1) [Rpt./5] II c. Pharmacy Administration Research (1) [Rpt./5] II

Pharmacy (PHIL)
Social Sciences Building, Room 213 (602) 621-3129


The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in philosophy. In addition to the traditional areas of philosophy, concentrations are available that bridge philosophy with other disciplines such as law or cognitive science.

Applications for the graduate program should normally have completed 30 units of undergraduate work in philosophy. In addition to application materials required by the Graduate College, applicants should submit to the department a copy of their completed application; a three-year transcript; a two-page statement of purpose to the department; a copy of their completed application; and a personal letter of recommendation from a philosophy instructor. GRE general aptitude scores, and a sample of their written philosophy work.

Degrees
Master of Arts: A student must demonstrate proficiency in logic, ancient, and modern philosophy; write a research paper. In addition, a preliminary examination must be passed, based on a research paper in an area chosen by the student. The student's program of study is designed individually. No thesis is required.

Doctor of Philosophy: A student must pass two courses in each of the following four distribution areas: (1) logic (required), philosophy of language, and philosophy of science; (2) history of philosophy; (3) epistemology and metaphysics; and (4) moral, social, and legal philosophy. The student's program of study is designed individually. No thesis is required.

503. Foundations of Mathematics (3) II 1990-91 (Identical with Math. 503)

512. Readings in Greek Philosophy (3) [Rpt.] (Identical with Grk. 512)


514. Philosophical Logic in Logic (3) [Rpt./2] One of the three principal branches of modern mathematical logic—recursion theory, model theory, or set theory—will be examined in depth. P, 413 or Math. 403.


519. Induction and Probability (3) Basic philosophical problems concerning justification of induction, confirmation of scientific hypotheses, and meaning of probability concepts.
521.* Philosophy of the Biological Sciences (3). Logical models in biology, studied in a context of evolutionary theory and other biological interpretations, reductionism, sociobiology. (Identical with Ecol. 521)

522.* Linguistic Semantics and Lexicology (3). Theoretical and empirical perspectives on the nature of language, including coordination, aspect, and modality. (Identical with Ling. 522)

523.* Philosophy of the Physical Sciences (3). Philosophical problems regarding space, time, motion, relativity, causality, measurement, theoretical and empirical commitments, and the role of language in scientific practice. (Identical with Ling. 523)

524.* Philosophy of Social Sciences (3). Theories, concepts, and forms of understanding in the social sciences. Possible topics: rational choice, social causality, decision theory, the individual and society, levels of democracy, and market mechanisms. One course in philosophy.

530a-530b.* Ethical Theory (3-3) 530a: Metaethics—meaning of moral terms, relativism, subjectivism, ethics, and social science, contract theory. 530b: Normative ethics—utilitarianism, egoism, rights, natural law, justice, deontological duties, blackmail and excuses.

533.* Aesthetics (3). Classical and contemporary theories of art: the esthetic experience, taste, and aesthetic value. (Identical with Pol. 533)

534.* Social and Political Philosophy (3). Fundamental concepts of politics; leading social and political theories, such as anarchism, social contract, Marxism.


538a-538b.* Philosophy of Law (3-3) 538a: Nature and validity of law, law and morality, judicial reasoning, law and liberty. 538b: Problems about justice, compensation and contracts and/or responsibility and punishment. (Identical with Pol. 538a-538b)

539.* Ethical and News Media (3) I (Identical with Jour. 539)

540.* Metaphysics (3). Topics include free will and determinism; causation; personal identity; necessity and essence; truth, realism and ontology.

541.* Theory of Knowledge (3). Critical examination of some of the major problems concerning evidence, justification, knowledge, memory, perception and induction. (Identical with Pol. 541)

542.* Knowledge and Cognition (3). Issues in philosophy of knowledge, including the role of conceptual schemes, with emphasis on cognitive mechanisms. Perception, memory, concepts, mental representation, problem-solving, reasoning and rationality. (Identical with Pol. 542)


550.* Philosophy of Mind (3). Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, memory, and action.

551.* Philosophy of Psychology (3). Investigation of philosophical issues arising from current work in psychology, including perception, reasoning, representation, and action.

553.* Minds and Machines (3). Philosophical problems arising from current work in artificial intelligence and cognitive psychology. (Identical with Ling. 553)

554.* Philosophy of Language (3). Survey of basic issues in the philosophy of language such as speech acts, reference, meaning, logical form, and reference.

556.* Formal Semantics (3). Introduction to model-theoretic investigations of natural language interpretation, including coordination, quantifiers, temporal relations, tense, aspect, and modality. (Identical with Ling. 556)

556.* Pragmatics (3-3) 1989-90 (Identical with Ling. 556)

557.* Frege and the Rise of Analytic Philosophy (3). The writings of Frege on logic, language, and mathematics and their influence on contemporary philosophical thought.

557a.* Greek Philosophy (3) I (Rpt./1) Topics in Greek philosophy. May be selected from the pre-Socratics, Socrates, Plato, Aristotle and Neo-Platonic, or Averroist philosophical. (Identical with Clas. 557a)

557a-557b.* Rationalism and Empiricism (3-3) 557a: Rationalists of the 17th and 18th centuries: Descartes, Spinoza, Leibniz, and Kant. 557b: Empiricists of the 17th and 18th centuries: Locke, Berkeley, Hume.

573.* Natural Language Processing (3) II 1990-91 (Identical with Ling. 573)

596. Seminar

a. Ethics (3) I (Rpt./2)

b. Metaphysics (3) I (Rpt./2)

c. Epistemology (3) I (Rpt./2)

d. Logical Theory (3) I (Rpt./2)

e. Social and Political Philosophy (3) I (Rpt./2)

f. Philosophy of Law (3) I (Rpt./2)

g. Philosophy of Mind (3) I (Rpt./2)

h. Philosophy of Language (3) I (Rpt./2)

i. Theory of Value (3) I (Rpt./2)

j. History of Philosophy: Ancient (3) I (Rpt./2)

k. History of Philosophy: Recent (3) I (Rpt./2)

I. Philosophy of Mathematics (3) I (Rpt./2)

m. Special Problems (3) I (Rpt./2)

v. Philosophy and Cognitive Science (3) I (Rpt./2)

Physical Education

(See Health-Related Professions)

Physics (PHYS)

PAS Building, Room 232 (602) 621-6800


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. The following courses in 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 in physics. The following courses in physics, carbon dating, surface science, quantum optics, biophysics, and general relativity. Theoretical research is conducted in solid state physics, atomic physics, nuclear physics, elementary particles, field theory, general rel

degrees

Master of Science: At least fifteen of the required thirty units of graduate work must be in physics and must include 511, 515a or the equivalent, and 536. Also, each student must satisfy one of the following courses: 511, 515a, 515b, 528, 565, and 665. The preliminary examination will cover classical mechanics, electromagnetic theory, relativity, statistical mechanics, experimental techniques, and an introductory course in quantum mechanics, modern physics, and questions on current developments. The courses 511, 515a-515b, 528, and 570a-57b indicate the areas covered in the examination. One semester of English is required. In the event of deficiency in physics, the student may be required to pass the English examination. The preliminary examination must be taken, at the latest, during the fifth semester (excluding summer sessions) of residence. If the student is expected to have completed the dissertation, the written and oral parts of the preliminary examination will be held in the fifth semester. Students intending to minor in physics will need to supplement a major in another department. They should consult the physics minor advisor in the Department of Physics.

Experimental research is conducted in the following areas: elementary particle physics, cosmic rays and space physics, solid state physics, atomic and molecular physics, nuclear physics, carbon dating, surface science, quantum optics, biophysics, and general relativity. Theoretical research is conducted in solid state physics, atomic physics, nuclear physics, elementary particles, field theory, general rel...
r, cosmology, astrophysics and none
brium statistical mechanics. Prospective
ents should write to the department for
ation about specific research programs,
ally with the facilities available, and
research and teaching assistantships or fel
ship support which can be offered. It is the
of the department to award financial aid e
for assistantships so as to provide a basis of the student's academic record and
ial needs. Fellowships are also available
-year graduate students.

* Medical Physics (3) I CDT Basic physics
the human body: the principles of
anics, electricity, sound, light, and radia
tics they apply to medical physics, with emphasis on physical instrumentation for diagnosis and treatment. 2b.

. Introduction to Quantum Optics (3) II
rical with Opt. 504a)

. Analytical Mechanics (3) I Laws of
on as developed by Newton, d'Alembert, range and Hamilton; dynamics of particles and rigid bodies. P. 410.

Topics in Advanced Mechanics (3) II
m topics in classical mechanics, includ
canonical perturbation theory, invariant
ntial equations, Green's functions, Wick's and Goldstone's theo
m including time-dependent and static
als of Maxwell's equations, radiation the
taxistics, and relativistic electrodynamics. P. 415b, b.

Advanced Thermodynamics and K
I CDT II 1989-90 First and second s
ics and thermodynamics and their applications; 3m. Thermodynamic equation; H-theorem, an free path methods applied to viscosi
cal, and diffusion. P. 425.

Statistical Mechanics (3) I Physical sta
cstics, the connection between the thermon
amic properties of a macroscopic system I the statistics of the fundamental compo
ns; Maxwell-Boltzmann, Fermi-Dirac, S
em-Bohr statistics. P. 475a -475b rec

Introduction to Biophysics (2) I CDT
cepts and experimental techniques of leaning biophysical properties of biological macromolecules and cell organelles, ical interactions, macromolecular transitions, leucin\nnermal evolution and regulation. P. 102b, am. Thermodynamics with Micro. 530.

Biophysical Theory (2) II Physical con
cts and theories describing biomolecular structure and function, molecular evolution, as to structure, symmetry, gon and virus
cture, organelle structure and function. sntical with Micro. 531)

Phyiscs Demonstrations (1-3) II Intro
ction to teaching materials and laboratory demonstrations illustrating principles of classi
and modern physics, with emphasis on 
ensive techniques and direct experience. vance credit available for none
ons only. P. two semesters of physics.

Advanced Atomic Physics (3) II 1990-91
tails of atomic structure; interactions of energy with electromagnetic fields, electrons, d ions; techniques for calculating unper
ed and perturbed energy levels, transition energies, and atomic interaction cross sec
cs. P. 570a -570b.

Applications of Introductory Quantum theory (3) II CDT Applications of quantum the
E to molecules, atomic nucleon, nuclear e
ons. P. 435.

Atomic and Molecular Spectro
I CDT Applications of quantum theory to molecules, atomic nucleon, nuclear particles. P. 435.

Atomic and Molecular Spectro
or for Experimentalists (3-3) Experiment
techniques to generate, analyze and detect phenomena from X-ray to IR; interpretation of spec
molecules; light scattering, polarization. P. 112b or 330. (Identical with Opti. 540a-540b)

Laser Physics (3) II (Identical with Opti

Experimental Physics 545a-545b-545c are three five-week lecture courses; none is prerequisite to any other.
a. Experimental Spectroscopy (1) I CDT
Laboratory experiments with spectros
copes, spectrometers, instrument func
ons, detectors, light collection optics, spectral recording and analysis. P. 110, 116, 121; or consult department before enrolling.
b. Experimental Acoustics (1) I CDT Labor
atory experiments with sound sources, oscilloscopes, spectrum analyzers, sound level meters, filters, musical instru
ments, recording, room acoustics. P. 110, 116, 121, or consult department before enrolling.
c. Experimental Microscopy, Light Scatter
ng and Optics of Small Particles I CDT Laboratory experiments with micro
scopes and polarized scattered light to characterize small particles and sur
aces, optical constants, lasers remote sensing. P. 110, 116, 121, or consult department before enrolling.

Introductory Nuclear Physics (3) II CDT
Basic concepts of nuclear physics: structure and stability of nucleus; nuclear forces; stable nuclei; structure of detectable systems; nuclear reaction characteristics. P. 112b or 330, Math. 254. (Identical with N.E.E. 550).

Nuclear Physics (3) I Theory of nuclear systems, including stability, decay nuclear forces, scattering, reactions, structure, and interaction with electromagnetic radiation at on. P. CR. 570a -570b.

The Many-Body Problem in Nuclear Physics (3) I (Rpt.) I 1990-91 Fermi gas model, Green's functions. Wick's and Goldstone's theo
res, theory of nuclear matter, microscopic
ory of finite nuclei. P. 570b.

Electrodyamics of Conducting Fluids and Plasmas (3-3) 1990-91 (Identical with Phys.S. 556a -556b)

Introductory Solid-State Physics (3) II CDT Properties of solids from molecular, atomic, and electronic, magnetic, and thermal properties of metals, insula
tors, and semiconductors; free electron and band theories. P. 112b or 330.

Physics of the Solid State (3) II Elemen
tary excitations in solids, phonons, electrons and holes, excitons, biexcitons, interaction of light with semiconductors, polaritons, high excitation phenomena, dielectric formalism of optical response, many-body effects in a Cou
lomb system. P. 460, 570a-570b, or Opti. 507 recommended but not formally required. (Identical with Opti. 561)

Quantum Mechanics (3-3) Princi
les of quantum mechanics; wave mechanics and matrix mechanics; applications to atomic structure and spectroscopy. P. 475a-475b rec
ommended but not required.

Symmetry Groups in Physics (3) I Algebraic results of the theory of groups which find represen tations in atomic, molecular, nuclear and particle physics. Continuous groups, Lie algebras, discrete groups, irreduc
tible tensors. P. 570a-570b.

Mathematical Physics (3-3) CDT Vector and tensor analysis; differential and integral equations; Green’s functions; variational techniques; linear opera
tors for theory, with particular physical applica

Theory of Relativity (3-3) 1989-90 Special theory of relativity and its application to mechanics and electrodynamics; tensor calc
ulus and general relativity; relativistic astrophysics and cosmology. P. 475b.

Advanced Relativistic Quantum Mechanics (3-3) 1990-91 Continuous groups; scattering theory; relativistic wave equations; quantum electrodynamics, Feynman diagrams, dispersion theory; renormalization; strong and weak interactions. P. 515b, 570a.

Quantum Field Theory (3-3) 1990-91 Meaning of quantized fields; symmetry principles, free fields; general properties of interactions and peculiarities of elec
trodynamics and gravity. P. 570b, 577a.

Elementary Particle Physics (3) II 1989-90 Production, interaction, and decay of mesons, baryons and leptons; high energy scattering of elementary particles; particle classification and symmetries; theoretical interpret
ation. P. 436.

High Energy Astrophysics (3) II 1989-90 (Identical with Astr. 582)

Plasma Physics and Ther
uclear Theory (3-3) II 583a: 583b: I. (Identical with N.E.E. 580a -580b)

Stellar Pulsation (1-3) (Rpt./5) I I Stellar pulsation, the solar atmosphere, solar seismol
ogy and long-term solar variability related to climate.

Techniques in Particle Physics (3) II 1990-91 Classification of elementary particles and their interactions with matter, relativistic kinematics and modern physics, with emphasis on physical applica
tions, statistical techniques, analysis of experiments, cosmic radiation, and accelerators.

Topics in Theoretical Astrophysics (3) I (Rpt.) I Current topics in theoretical astrophysics in depth, with emphasis on the method ology and techniques of the theorist and the cross-pollination of ideas. Example subjects are nuclear astrophysics, hydrodynamics, transient phenomena, planet
ary interiors and atmospheres, neutron stars, jets, and the evolution of star clusters. (Identical with Astr. 589 and Phys.S. 589)

Seminar a. Current Problems in Molecular Biophysics (1) I (Rpt.) I (Identical with Micro. 596a)

The Physics of Thin Films (3) II P, 460.

Graduate Physics Laboratory (3) (Rpt./2) I Introduction to modern research methods and the design and construction of instruments; computer-based data acquisition and analysis; solar-energy physics; and others.

Colloquium a. Current Problems in Physics (1) I (Rpt.) I St
The interdepartmental Committee on Physiological Sciences offers graduate work leading to the Doctor of Philosophy degree with a major in physiological sciences. Research training is an integral part of the Ph.D. program. The research areas of the faculty in the program include: cellular and transport mechanisms; circulatory and respiration, including microcirculation; comparative physiology; endocrinology; exercise physiology; gastrointestinal physiology; muscle physiology; neuromotor mechanisms; ion transport; renal mechanisms; and reproductive and developmental mechanisms.

Applicants for the Ph.D. program in physiological sciences should hold a bachelor's degree in the physical or biological sciences, engineering, mathematics or other suitable field. They should have completed one year of physics (including laboratory), mathematics through calculus (two semesters), and biochemistry. Statistics, physical chemistry and differential equations are not required but are highly desirable. Familiarity with microcomputers and a programming language is an introductory course or readings in biology or zoology is advisable for physical science majors. The Graduate Record Examination and health related sciences. Open to pharmacy majors; others consult department before enrolling. P, Chem. 103b, 104b, 241b, 243b; Math. 125a - 125b; Bioc. 460. May enroll for credit in 601 or 602, but not both. Credit is required for the M.D. degree. All others must obtain permission of the instructor before enrolling. Graduate students already enrolled in the College of Medicine departments will be given preference. In addition to the courses listed below, the Department of Physiology offers two courses in the following areas, subject to faculty availability and student interest: neurophrophysics; renal physiology; physiology of muscular contraction; renal physiology; renal physiology; gastrointestinal and developmental physiology; membrane transport processes in physiology, and cardiac physiology.

503. Cellular Physiology (4) I Fundamental responses of living organisms to environmental changes, by examining mechanisms which operate at the cellular level. Topics include organelle structure and function, transmembrane homeostasis and transport phenomena, excitability, intercellular and intracellular communication, cellular mobility, and nervous-muscle-synapse function. P, Chem. 103b, 104b, 241b, 243b; Phys. 102b; Math. 125a-125b; Bioc. 460. (Rpt. /12 units) I

581. Human Physiology (4) II Principles of physiology with emphasis on the human; designed primarily for students in pharmacy and health-related sciences. Open to pharmacy majors; others consult department before enrolling. P, Chem. 243b, Math. 123, Phys. 102b, CR. 581. (Identical with Tox. 580) II

581A. Physiology Laboratory (1) 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 department before enrolling. P, Chem. 243b, Math. 123, Phys. 102b, CR. 580. II

582. Topics in Neurological Pathology (2) II Available as both 595 and 895 I

583. Principles of Systems Neurobiology (4) I (Identical with Nsc. 588) II

595. Colloquium a. *Mathematical Techniques in Physiology (2) [Rpt./12 units] II I II Phys. 125a-125b; Bio. 243b

b. *Muscle Physiology (2) [Rpt./12 units] II

c. *Endocrinology (2) [Rpt./12 units] II

d. *Renal Physiology (2) [Rpt./12 units] II 601/801, 602.

e. *Molecular and Cellular Excitability (2) [Rpt./12 units] II


g. *Membranes and Transport (2) [Rpt./12 units] II

h. *Systems Neurophysiology (2) [Rpt./12 units] II

i. Introduction to Personal Computers (2) [Rpt./12 units] II

j. *Cellular Physiology (2) [Rpt./12 units] II

k. *Endocrinology (2) [Rpt./12 units] II

l. *Renal Physiology (2) [Rpt./12 units] II

596. Seminar a. Physiology Series (1) [Rpt./3] I II open to majors only.
b. Physiology: Preparation and Presentation (1) [Rpt./] I II open to majors only. Consult department before enrolling.
c. Physiology Open Forum (1) [Rpt./3] II

601. Systems Physiology (8) II Comprehensive coverage of systems physiology with emphasis in the underlying principles of function. Provides an overview of systems level neurophysiology and, in conjunction with 602, concludes with an integrative section. P: Chem. 103b, 104b, 241b, 243b; Phys. 102b. May enroll for credit in 601 or 602, but not both. Corequisite: department before enrolling.

602. Systems Physiology for Neuroscientists (7) II Comprehensive coverage of systems physiology with emphasis on the underlying principles of function. Includes views of cardiovascular, renal, respiratory, gastrointestinal, and endocrine physiology. Concludes with an integrative section. Open in conjunction with 601 and 602. P. Chem. 103b, 104b, 241b, 243b, Phys. 102b. May enroll for credit in 601 or 602, but not both. Corequisite: department before enrolling.

605. Neurosciences (6) II (Identical with An 605)

610. Research Methods in Physiology I: [Rpt./10 units] II Laboratory course provides students with an understanding of the types of research available in the department. (Maxim length is 8 weeks). Consult with department before enrolling.

855. Colloquium a. Motor Control (2) [Rpt./8 units] II (Identical with Ex.S.S. 695a)

856. Seminar a. Physiology Series (1) [Rpt./3] II I II open to majors only.
b. Physiology: Preparation and Presentation (1) [Rpt./] II open to majors only. Consult department before enrolling.
c. Physiology Open Forum (1) [Rpt./3] II


801. Human Physiology (8) II

805. Neurosciences (6) II (Identical with An 805)

891. Preceptorship a. Physiology (3-12) [Rpt./12 units].

895. Preceptory a. *Mathematical Techniques in Physiology (2) [Rpt./12 units] II I II Phys. 125a-125b; Bio. 243b

b. *Muscle Physiology (2) [Rpt./12 units] II

c. *Endocrinology (2) [Rpt./12 units] II

582. Special topics in Neurological Pathology (2) II
The Department of Planetary Sciences and the Lunar and Planetary Laboratory are active participants in many missions of the NASA space science program. The laboratory's Space Interagency 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 10 imagery of Venus and Mercury; and Pioneer 10 and 11 and Voyager results for Jupiter and Saturn all of which are available to students for research purposes. Also available for student research are the facilities of the University of Arizona's observatories, including 154-cm, 15m, 10m, and 07m reflectors in the Santa Catalina Mountains north of Tucson; and 229-cm, 03m, and 05m reflectors on Kitt Peak west of Tucson, as well as the Multiple Mirror Telescope on Mt. Hopkins, which is a joint project of the University of Arizona and the Smithsonian Astrophysical Observatory. Laboratory facilities for cosmochemistry and geochemistry include a scanning electron microscope, an experimental petrology laboratory, a radiochemistry separation laboratory, and a neutron activation analysis laboratory. The laboratory also maintains a state-of-the-art digital imaging system, and a nuclear reactor located on campus and operating for isotope research and activation analysis.

The University has a well-equipped computer center. The Lunar and Planetary Laboratory maintains a number of special-purpose computers, which can be used interactively for such special applications as inversion of Fourier interferograms and reduction of data from various space programs, and other student research projects.

503. Introduction to the Solar System (3) I 1989-90 Survey of planetary physics, planetary motions, planetary interiors, geophysics planetary atmospheres, asteroids, comets, origin of the solar system. This course does not count toward the major requirements in planetary sciences. P, Phys. 103a-103b. (Identical with Geos. 503)

504. Exploration of the Solar System (3) I Survey of the major instruments of modern space exploration; planetary science fundamentals, solar system physical properties; planetarium demonstrations, classroom projects. Field trip, graduate credit available for science majors. (Identical with ASTR. 504)


510. Principles of Cosmochemistry (3) I 1990-91 Chemical compositions of solar system objects; equilibrium and nonequilibrium chemical processes applied to planets; cosmochemistry. P, 403. (Identical with Geos. 510)


518. Modern Inertial Guidance and Navigation Techniques (3) I 1989-90 (Identical with ASTR. 518)

519. Global Thermodynamic Processes (3) I (Identical with Geos. 519)

*May be convened with 400-level course.

520. Meteorites (3) I 1989-90 Classification; chemical, mineralogical and isotopic composition; cosmical 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)

530. Chemical Evolution of the Earth (3) I (Identical with Geos. 530)

544. Physics of High Atmospheres (3) I 1989-90 Physical properties of upper atmospheres, including gaseous dynamics, temperature and density, ozonosphere, and ionospheres, with emphasis on chemical transformations and eddy transport. (Identical with ASTR. 544)

545. Stellar Atmospheres (3) I 1989-90 (Identical with ASTR. 545)


555. Remote Sensing of Planetary Surfaces (3) I 1989-90 Exploration of planetary surfaces, including that of the Earth, with remote sensing. Emphasis on compositional analysis using visible and infrared methods. Basic principles, image and spectroscopic analysis techniques, and case studies in planetary remote sensing. (Identical with ASTR. 555 and Geos. 555)


562. High Energy Astrophysics (3) II 1989-90 (Identical with ASTR. 562)

569. Topics in Theoretical Astrophysics (3) I (Rpt.) (Identical with Phys. 569)

596. Seminar

Planning (PLNG)

Committee on Planning (Graduate)

Professors Arthur L. Silvers (Management and Policy), Chairperson, Lay J. Gibson (Geography and Planning), Herbert Gieseke (Architecture), David A. King (Renewable Natural Resources), Gregg (Renewable Natural Resources), Robert G. Strom (Architecture), Thomas F. Saarinen (Geography)
The Committee on Planning offers graduate professional programs leading to the Master of Science and Doctor of Philosophy degrees with a major in planning. Concentrations are offered in the fields of policy and planning (Management and Policy; College of Business and Public Administration) and in regional (Geography; Faculty of Social and Behavioral Sciences). Additional concentrations currently under development are in community design (College of Architecture) and natural resources planning (School of Renewable Natural Resources). All students pursuing the M.S. with a major in planning are required to complete a basic core program consisting of fifteen units. The core includes Ping. 557, 602, 605, 609 and 612b.

The concentration in policy and planning provides a variety of skills and careers in state and local government. Competence in problem solving in the public sector is strengthened by combining analytic, computer, financial, and social sciences courses with hands-on experience through workshops and field internships. Areas of specialization are land use and the environment, health care services, planning, and public facility planning. In addition to the basic core, students in the concentration in policy and planning must complete M.I.S. 501, Ping. 608 and 612a, Econ. 500a, 601 and 609. The concentration in regional planning provides a strong grounding in location and spatial analysis, environmental behavior, and in legal/ political institutions for regional infrastructure. Students are exposed to current field applications and are expected to have a general education and technical expertise. Areas of specialization are land use and the environment, regional development, techniques for regional analysis, and transportation and human interaction. In addition to the basic core, students in the program in regional planning must complete Ping. 556, 557, 608 and 659.

506. Fundamentals of Physical Planning (3) (Identical with M.A.P. 506)
507. Social Service Planning (3) (Identical with M.A.P. 507)
510. Development of Regional Planning (3) (Identical with Geog. 510)
544.* Site Planning (2) (Identical with Arch. 544)
550. Metropolitan and Regional Planning (3) (Identical with Geog. 550)
553.* Location Analysis (3) (Identical with Geog. 553)
556. Urban Systems Analysis (3) (Identical with Geog. 556)
557.* Statistical Techniques in Geography and Planning (3) (Identical with Geog. 557)
561. Resource Management (3) (Identical with Geog. 561)
563. Perception of Environment (3) (Identical with Geog. 563)
565. Project Planning and Modeling (3) II (Identical with C.E. 565)
566.* Urban Transportation Planning (3) II CDT (Identical with C.E. 566)
571.* Problems in Regional Development (3) II (Identical with Geog. 571)
573.* Land Use and the Urban Environment (3) II (Identical with Geog. 573)
575. Housing and Residential Areas (3) II (Identical with M.A.P. 575)
581.* Computer Cartography (3) II (Identical with Geog. 581)
583.* Geographic Applications of Remote Sensing (3) II (Identical with Geog. 583)

584.* Planning the Built Environment (2) I (Identical with Arch. 584)
596. Seminar
u. Interdisciplinary Environment-Behavior-Design (3) I (Identical with ids. 596u, which is home)
597. Workshop
a. Architecture (3-8) [Rpt.] II (Identical with Arch. 597a, which is home)
* May be convened with 400-level course.

602. Analytic Methods in Planning and Management (3) II Methods and models for program planning and policy analysis; forecasting, service demand, facility location in capital investment programming, task sequencing, program analysis and evaluation. P, 457 or M.I.S. 552. (Identical with M.A.P. 602)
605. Planning Theories and Perspectives (3) I (Identical with Geog. 605)
606. Planning Law (3) II (Identical with Geog. 606)
609. Policy Problems in Structure and Change (3) II (Identical with M.A.P. 609)
611. Projects in Regional Planning (1-5) [Rpt./5 units] II (Identical with Geog. 611)
612a-612b. Projects in Policy and Planning (2-3) (Identical with M.A.P. 612a-612b)
651. Health and Public Policy (3) II (Identical with M.A.P. 651)
655. Efficiency Analysis in Health Administration III (3) II (Identical with M.A.P. 655)
657. Spatial Analysis (3) II (Identical with Geog. 657)
659. Growth Controls (3) II (Identical with Geog. 659)
662. Aging and Public Policy (3) I (Identical with M.A.P. 662)
665. Quick Response Transportation Planning Methods (3) I 1989-90 (Identical with C.E. 665)
668. Urban Public Transportation Systems (3) I 1990-91 (Identical with C.E. 668)
669. Preservation of Historic Environments (3) II 1989-90 Current planning and legal methods to enhance the preservation of historic urban areas and structures; concentration analysis of selected case studies. Field trips.
693. Internship (1-4) I (Identical with Geog. 693)
696. Seminar
h. Land-Use Regulation (3) I II (Identical with M.A.P. 696h, which is home)
i. Legal Inquiry in Policy and Planning (3) II (Identical with M.A.P. 696i, which is home)
j. Environmental Planning (3) II (Identical with M.A.P. 696j, which is home)
k. Planning Administration (3) II (Identical with M.A.P. 696k, which is home)
o. The General Plan (3) [Rpt./6 units] II (Identical with Geog. 696o, which is home)
p. The Land Development Process (3) [Rpt./6 units] II (Identical with Geog. 696p, which is home)

**Plant Pathology (PLP)**

Forbes Building, Room 104 (602) 261-1828


Assistant Professors Martha C. Hawes, Alan J. Howarth

The department offers majors in Master of Science and Doctor of Philosophy degrees with a major in plant pathology. Concentrations are available in bacteriology, mycology, nematology, virology, physiology, parasitism, genetics of pathogens, disease economically important plants and soil fungi.

Applicants should have background in botanical sciences and undergraduate credit in college algebra and trigonometry (calculi also recommended), microbiology, genetics, physics, two years of organic chemistry, and biochemistry.

At least fifteen units in plant pathology may be completed for the master's degree. A decision to require a waiver of the master's degree thesis will be altered based on the student's preparation, progress in this program, and professional objectives.

For information concerning the Doctor of Philosophy degree see Requirements for Doctoral Degrees/Doctor of Philosophy elsewhere in the catalog.
Science degree with a major in plant science, as major was under review at the time of log editing. Prospective students should consult the College of Agriculture for further information.

ent Sciences (PLS)

ses Building, Room 201

2) 621-1977

essors Brian A. Larkins, Head, Paul G. Bar-

ils, Robert E. Briggs, Albert K. Dobrenz, Rich-

, Fredric R. Lehle, Harold M. Sisco, William B. Miller, John W. 

, Karen K. Oishi, David A. Palzkill, 

Thom 

stant Professors Douglas A. Bailey, Janice I. Coons, Alan H. Goldstein, Fredric R. Lehle, Harold M. Sisco, William B. Miller, John W. 

Arid Land Crop Ecology (3) 1990-91 Environmental factors affecting ger-

mination, growth, development, and quality of vegetable crops; physiological problems unique to vegetables; presentation and interpretation of recent research progress. P. 361. Ecol. 260 or M.C.B. 460.

nt Methods in Plant Physiology (4) I Current techniques for qualitative and quantitative studies of physiological and bio-

chemical processes. 1R, 9L. P, Ecol. 260 or M.C.B. 460.

nt Intermediary Metabolism (3) II 1990-91 (Identical with M.C.B. 562)

nt Growth and Development (3) 1989-90 (Identical with M.C.B. 564)

Postharvest Physiology (1) II 1989-90 Biochemical and biophysical changes associ-

ated with the maturation, ripening and senes-


nt Physiology (1) II 1989-90 Physiolog-

y of seed development, germination and dormancy. P. Ecol. 260 or M.C.B. 460.

nt Cell and Tissue Culture (3) II Prin-

ciples and theory of callus induction, embryoid and plantlet regeneration, nutrient transport, protoplast culture and fusion and cell suspension. 2R, 9L. P, Ecol. 260.

May be considered for 400-level course

nt Communication and Research Methods (4) II 1989-90 Techniques and limitations of written, oral and visual scientific communication; procedures and policies for research funding sources. P. 361 or Ecol. 260.

nt Breeding (3) II 1990-91 Critical study of the theoretical basis for plant 

breeding procedures. P. 415 or 515 or An. S. 413 and A.E. 539.

nt Cytogenetics (4) II 1990-91 Molecular and classical cytogenetics including 

analysis of alterations in chromosome structure, and cytogenetic principles of aneuploids, hap-

loids and polyploids. Emphasis on plant king dom. 3R, 2L. P. 6 units of genetics. (Identical with Gene. 635)

nt Cell Cultures (2) II 1989-90 A study of the genetic changes that occur during growth of plant cells, and genetic manipulations in vitro including mutati on selection, genomic rearrangements, somatic hybridization. P. 512 or Ecol. 320. Ecol. 260 or M.C.B. 460. (Identical with Gene. 638)

ntennial

a. Plant Science (1) [Rpt./4] II

Political Science

Social Sciences Building, Room 315

(602) 621-7600


Assist 


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 politics, comparative politics, public policy, political behavior, international relations, American and comparative policy studies, and comparative politics. The Master of Arts degree is designed as a basic program for students who plan to continue into a Ph.D. program. In addition, the department also offers programs for students interested in government careers, community college teaching, and international or domestic policy. The Master's Degree is designed as a second degree for students interested in the study of 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. Students interested in concentrating in political science will be made by the department after consideration of the student's preparation, proposed program, and professional objectives. Students in a non-thesis degree program must fulfill a minimum of 36 units of course work. A Master of Science thesis requirement may be made by a student who is a senior author on a manuscript published or accepted for publication in a refereed professional journal, and which the student believes to be relevant to admission.

Programs are planned, in consultation with an advisory committee, around the student's principal area of interest, emphasizing one or more of the areas of concentration listed above.

Degrees

Master of Arts: Each student must specialize in either one or two of the six fields of concentration listed above and complete at least 30 units of course work with at least 24 units at the 500 and 600 levels. A supervised research essay 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 enrolled in the master's degree at the University of Arizona.

Bureaucracy, Politics, and Policy (3) Development and analysis of the executive branch of government: how federal agencies capture policy-making; how bureaucracy develops; the rules of bureaucratic culture; who controls the administrative branch.
507.* Congress and American Politics (3) I II Examination of election politics, personalities, and career patterns of congressional members, the organization and structure of Congress, and the role of Congress in policy leadership and representation. 34-620 to the present through films and readings.

512.* Local Government and Administration (3) I II Examination and analysis of local decision-making structures and their policy outputs. P. 130.

521.* Ancient and Medieval Political Theory (3) I Development of Western political theory from the Greeks to Machiavelli.

522.* Early Modern Political Theory (3) II Western political theory from Machiavelli to Marx.

523.* Recent Political Thought (3) II Political theory from Marx to the present.

526. Cross-National Research Methods (3) II Presentation of strategies for development of the manner in which attitudes about politics and policy processes are acquired from exposure to mass and television, and the manner in which such attitudes lead to political action.

532.* Pressure Groups (3) 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, external organization, and membership loyalties.

535.* Public Opinion and Voting Behavior (3) 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. 536).

536.* Political Socialization (3) II Description and analysis of how and why people wield, and respond to, authority. Based on presumption that people's reactions to the public order are influenced by the private order—or disorder—of their minds and the way they learned to respond to the private authorities of their childhoods.

537.* Democracies, Emerging and Evolving (3) I Causal analysis of conditions of stability and breakdown of democratic regimes with particular attention to the developing democracies of the third world.

538a-538b.* Philosophy of Law (3-3) (Identical with Phil. 538a-538b).

541.* Arab-Israeli Conflict (3) I II Traces the birth and growth of the Arab-Israeli conflict since 1948 with particular attention to the internal impediments to conflict resolution on both the Arab and Israeli sides. Also surveys the role of the great powers in Middle East politics generally. (Identical with Or.S. 541).

542.* Transformation of Agrarian Societies in the Middle East (3) II (Identical with Or.S. 542).

543.* Soviet Politics (3) I Revolution and contemporary ideology; state, party, and mass organizations; economic and social planning; civil liberties; models of autocracy and pluralism.

544.* East European Politics (3) II Divergent models of Communist development, from East Germany to Yugoslavia; political, economic, social, and cultural reform.

545.* Overview of the European Political Revolution (3) I Examination of the causes and consequences of 20th-century revolutions and the revolution- ary process, with emphasis on contemporary events.

547.* Latin-American Political Development (3) II Presentation of strategies for development in Latin America; examination of case studies from Cuba, Brazil, Chile, Guatemala, and other countries. Open to juniors and seniors only.

548.* Government and Politics of Mexico (3) I I Description and analysis of Mexico's political structure; acceptance of the foreign policy, with emphasis on Mexican-U.S. relations.

549.* The Politics of Cultural Conflict (3) II Comparative examination of the approaches of different political systems to domestic conflict of a racial, religious, linguistic, and/or ethnic nature.

550.* Religion and Politics (3) II A comparative examination of the relationship between religion and politics in the contemporary world.

551.* Soviet Foreign Policy (3) I I Ends and means of Soviet foreign policy; the decision-making process; Soviet relations with the West and developing nations.

552.* Communist Foreign Relations (3) II Interrelations of fourteen Communist-party states, with emphasis on cooperation and conflict in such organizations as the Comecon and the Warsaw Pact.

554.* Problems of World Order (3) I Introduction to theories of international relations on the levels of man, the nation-state, and the international system, with a logical and empirical examination of theories and factors.

555.* American Foreign Policy (3) I II Analysis of the Cold War; Congressional-Executive clashes over foreign policy control; approaches to policy.

556.* International Law (3) The international state system; legal-political problems, including territory, environment, seas.

557.* Pressure Groups (3) I Survey and analysis of the leading political and economic issues at controversy between the United States and Latin America.

564.* International Relations of East Asia (3) II National interests, issues and conflicts, relationship between economic politics and interstate relations in East Asia. (Identical with Or.S. 564).

565.* Population and Development in the Middle East (3) I (Identical with Or.S. 567).


574.* Administrative Law (3) I Law governing the organization, and procedures of the executive and administrative establishment, with emphasis on the limitations imposed by the American constitutional system.

576.* Women and the Law (3) I 1990-91 Legal status of women in America, including constitutional protections, marriage and family relationships, educational and vocational opportunities, political rights, criminal law.

579. Research Design (3) I Introduction to experimental and quasi-experimental research designs, 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 discipline and to prepare them for scholarly research in the field.


582. Research and Methodology (4) I Qualitative techniques and computer applications in political science.

583.* Urban Public Policy (3) II I Analysis of the discussion of social, economic, and polices and proposed solutions in changing urban environments.

584a-584b.* Development of Federal India Policy (3-3) I European colonial predestines through the treaty-making period; 584a End of treaty-making to the present. 584a is a prerequisite to 584b. (Identical with As. 584a-584b).

585. Political Risk and Intelligence Analysis (3) I II Examination of political risk and intelligence analysis with emphasis on forecast and developments in nations.

586.* Political Systems of India I Pakistan (3) I II (Identical with Or.S. 586).

587.* Race and Public Policy (3) I II Examination of the race issue in American politics, from historical, behavioral, and comparative perspectives. (Identical with As. 587 and Bl.S. 587).

588.* The Politics of National Policymak (3) I II Analysis of institutional and political role for cooperation and conflict between Congress; the President, and the Court in different political areas.

595. Colloquium a. American Political Institutions (3) II I b. Political Behavior (3) II I c. Survey of Political Theory (3) I II d. Comparative Politics (3) II I e. International Relations (3) I II f. Public Policy (3) I II


696. Colloquium a. American Political Institutions (3) II I b. Political Behavior (3) II I c. Survey of Political Theory (3) II I d. Comparative Politics (3) II I e. International Relations (3) II I f. Public Policy (3) II I g. Public Policy (3) II I h. American Indian Law and Policy (3) II I (Identical with A.In. 596) i. Water and Equity in the Southwest (3) II I j. Southwest Bibliography (3) II I (Identical with Hist. 596m, which is home) 610a-610b, Fiscal and Budgetary Administration of Public Agencies (3-3) (Identical with M.A.P. 610a-610b).

696m. Seminar v. Public Choice I II (Identical with Econ. 696v, which is home) w. Public Choice II (3) II (Identical with Econ. 696w, which is home)

Portuguese (See Spanish and Portuguese)

Psychology (PSY 4)
Psychology Building, Room 312 (602) 621-7447

Professors Lee Secrest, Head, Neil R. Bardt (Emeritus), Robert B. Bechtel, Allan Beg (Psychiatry), Larry E. Beuter (Psychiatry)
510. Advanced Social Psychology (3) \[I\] \[II\] Social psychology, with emphasis on theory and method. P, 255, 300.


512. Animal Learning (3) \[II\] Animal learning with emphasis on interspecies comparisons. P, 255.

514. Personality and Social Development (3) \[I\] \[II\] Research and theory in developmental psychology with an emphasis on social cognition, social and emotional growth. P, 255, 313.

515. Contemporary Issues in Psychological Assessment and Test Construction (3) \[Rpt., 1\] Introduction to major theories, methods, and research findings associated with the development of cognitive and intelligence. P, 255, 313.

516. Advanced Personality (3) \[I\] \[II\] Advanced study of theories of personality; methods and results of personality study. P, 255, 316.

518. Abnormal Psychology (3) \[I\] \[II\] Nature and etiology of various forms of behavior disorder, mental deficiency, and other deviations; critical evaluation of current theories. P, 255.

520. Neurobiology (3) \[Rpt., 1\] \[II\] Recent advances in neurobiology with a strong emphasis on cellular and molecular mechanisms of nervous system function.

521. Psychology of Death and Loss (3) \[I\] \[II\] Basic concepts in a psychology of death and loss, with emphasis on both the adjustment to death and loss, and the underlying phenomena of humanistic and current social considerations. P, 255 or graduate standing.

522. Psychobiology (3) \[Rpt., 1\] \[II\] Recent advances in psychobiology, with a strong emphasis on the neural bases of sensation, perception, memory, learning, and thinking.

524. Animal Behavior (3) \[Rpt., 1\] \[II\] Recent advances in the study of behavior from an ethological/evolutionary perspective.

527. Field Methods in Environmental Psychology (3) \[II\] Behavior in man-made or managed environments, with emphasis on objective methods; designed for students having a professional interest in environmental design or management. P, 371 or graduate standing. (Identical with Arch. 527 and L.A.R. 527)

528. Cognitive Neuroscience (3) \[Rpt., 1\] \[II\] Recent advances in cognitive neuroscience, with an emphasis on neural processes and cognitive neuroscience. P, 255, 300, 6 units of a social science, or graduate standing.

530a-530b. Psychology of Personality and Social Policy (3-5) \[II\] Variable content, including development, theory, and research in the psychology, law and social policy interface. P, 255, 300, 6 units of a social science, or graduate standing. 530a is not prerequisite to 530b.

535. Psychological Problems of the Aged (3) \[I\] \[II\] Cognitive, intellectual, personality, and behavioral correlates of aging; relates general psychological theory to the problems of aging. P, 255; or 101 and two courses on gerontology or graduate standing. (Identical with Ger. 535)

540. Perception and Attention (3) \[Rpt., 1\] \[II\] Recent advances in the area of perception and attention, with an emphasis on visual processing.

542. Psycholinguistics (3) \[Rpt., 1\] \[II\] Recent advances in the area of psycholinguistics, with an emphasis on sentence processing and the contribution of linguistic theory to an understanding of psychological mechanisms. P, 255.

544. Cognitive Neuropsychology (3) \[Rpt., 1\] \[II\] Recent advances in the area of cognitive neuropsychology, with an emphasis on the contribution of the brain to cognitive activities; includes cutting-edge memory, thinking, learning, and perceiving.

546. Environmental Cognition (3) \[Rpt., 1\] \[II\] Recent advances in the area of environmental cognition, with an emphasis on cognitive aspects of environmental psychology.

550. Psychological Assessment and Testing (3) \[II\] Evaluation of assessment processes and of measurements of intelligence, aptitudes, personality, and interests; test theory; social implications. P, 255.

551. Acquisition of Speech and Language (3) \[II\] \[Identical with Sp.H. 551\]

553. History and Methods of General Psychology (3) \[II\] \[Identical with Sp.H. 553\]

554. Research and Theory in Developmental Psychology (3) \[II\] \[Identical with Sp.H. 554\]

558. Psychopathology (3) \[II\] \[Identical with Sp.H. 558\]

560. Law and Social Science (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 560\]

562. Mental Health Policy (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 562\]

565. History of Psychology (3) \[II\] \[Identical with Sp.H. 565\]

566. Topics in the Biological Bases of Behavior (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 566\]

570. Cognitive and Affective Sciences: Psychology of Personality and Social Policy (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 570\]

574. Cognitive and Affective Sciences: Psychology of Personality and Social Policy (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 574\]


580. Clinical Neuropsychology (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 580\]

582. Psychopathology (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 582\]

585. Psychological Assessment and Testing (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 585\]

586. Psychopathology (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 586\]

587. Topics in Social Bases of Behavior (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 587\]

588. Topics in Social Bases of Behavior (3) \[Rpt., 1\] \[II\] \[Identical with Sp.H. 588\]
596. Seminar
a. Clinical Psychology (3) [Rpt./1] II
b. Personality Psychology (3) [Rpt./1] III
c. Developmental Psychology (3) [Rpt./1] II
d. Environmental Psychology (3) [Rpt./1] II
e. Biopsychology (3) [Rpt./1] II
f. Cognitive Psychology (3) [Rpt./1] II
g. Clinical Psychology (3) [Rpt./1] II
h. Law, Psychology, and Policy (3) [Rpt./1] II
i. Quantitative Methods (3) [Rpt./1] II
j. Politics of Psychology (2) [Rpt./4 units] II
k. Interdisciplinary Environment-Behavior Design (3) [Rpt./1] (identical with Ids. 596u, which is home)

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 graduate psychology majors only.

625. Clinical Community Psychology (3) II Expanding role of psychology in innovative mental health facilities, with emphasis on consultation, program development, primary prevention and social system modification. Open to majors only.

628. Psychotherapy (3) [Rpt./2] II Current research and theory in psychotherapy. Alternate semesters will emphasize individual insight, behavioral, and treatment approaches.

694. Practicum
a. Clinical Interviewing and Assessment (1-3) [Rpt./1] II Open to clinical psychology students only.

695. Colloquium
a. Motor Control (2) II (identical with Ex.S.S. 695a)

Public Administration (See Public Administration and Policy)

Public Administration and Policy

Harvill Building, Room 453
(602) 621-7965

Professors Michael Gottfredson (Management and Policy, Psychology), Helen Ingram (Political Science), Theodore Koff (Management and Policy), John Schwartz (Political Science), Lee Sigelman (Political Science), Arthur Silvers (Management and Policy)

Associate Professors H. Brinton Milward, Director, Management and Policy, Walter Powell (Management and Policy, Sociology), Ronald Vogel (Management and Policy)

The School of Public Administration and Policy offers the Master of Public Administration, which is designed to prepare men and women for positions of leadership in public sector and nonprofit organizations, as well as private organizations dealing with the public sector. Graduates may expect to pursue management or policy making concerns in a wide variety of settings within organizations at local, state, national, and international levels.

For admission and degree requirements, please see Master of Public Administration elsewhere in this catalog.

Public Management (See Management and Policy)

Public Policy, Planning and Administration (See Management and Policy)

Range Management
(See Renewal Natural Resources)

Reading
(See Education)

Real Estate
(See Finance and Real Estate)

Regional Development
(See Geography and Regional Development)

Rehabilitation
(See Education)

Reliability Engineering
(See Systems and Industrial Engineering)

Remote Sensing (REM)

1002 N. Warren Avenue, Room A17
(602) 621-4242

Committee on Remote Sensing (Graduate)

Professors Philip N. Slater (Optical Sciences), Chairperson, Victor R. Baker (Geosciences), Dinhaw N. Contractor (Civil Engineering), Benjamin D. Veitch (Electrical Engineering), Donald F. Post (Soil and Water Sciences), John A. Reagan (Electrical and Computer Engineering), Richard W. Reeves (Geography and Regional Development)

Associate Professors Charles E. Glass (Mining and Geological Engineering), John W. Olsen (Anthropology), William O. Rasmussen (Agricultural Engineering), Robert A. Schowengerdt (Electrical and Computer Engineering; Arid Lands Resources Sciences) Assistant Professor Alfredo R. Huete (Soil and Water 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 this time, but minor programs are available for doctoral students with majors in disciplines within the Colleges of Agriculture, Business and Public Administration, Engineering and Mines, Arts and Sciences; and the Office of Arid Lands Studies and the Optical Sciences Center. Emphasis are available in applied remote sensing or in remote sensing techniques.

Students entering the program 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. 507 or Ws.M. 520. The remaining units may be selected from Ws.M. 522, C.E. 554, Geog. 583, 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 024, 539, 558, 559, 567, Atmo. 561, 656a-658d, 663.

Students are urged to discuss the program with members of the Committee on Remote Sensing before selecting the courses to take. The program selected must be approved in advance by the committee.

696. Seminar
a. Remote Sensing (1) II 1990-91

Renewable Natural Resource (RNR/LAR/RAM/WSM/WFSC/ NRR)

Biological Sciences East, Room 325
(602) 621-7255


Assistant Professors Robert M. Itami, Ann K. Lynch, Mitchel P. McClaran, E. Greg McPherson, Bruce A. Roundy, Frank W. Tews, Rudi (Tree-Ring Laboratory)

The School of Renewable Natural Resource offers programs leading to the Master of Science and the Doctor of Philosophy degree in 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 the Doctor of Philosophy degree, see Requirements for Master's Degrees/Master's 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 Master of Science 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) in 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 with their environment, particularly those involving plants, animals, soil, and climate.

Majors

Watershed Management or Range Management: Concentrations are available in water science, watershed management, forest-watershed management, land use, and range science. Students should normally have completed an undergraduate major in watershed management, range management, natural resource recreation, or for
...duents working toward the Master of Sci-
degree may select either of two plans: (1)ple a major field of study or (b) 36 units including a mini-
...tional, natural resources recreation.

7. Principles of Research (3) Principles of research with special emphasis on methodology and applications. (Identical with S.W. 517, 518, and 519.)


9. Advanced Environmental Systems (3) Integrated environmental systems analysis and management. (Identical with S.W. 520, 521, and 522.)

10. Environmental Policy (3) Environmental policy and management. (Identical with Pol. 523.)

11. Environmental Law (3) Environmental law and regulation. (Identical with Pol. 524.)

12. Water Quality Management (3) Water quality management and control. (Identical with Pol. 525.)


15. Water Resources Planning (3) Water resources planning and management. (Identical with Pol. 528.)

16. Seminar (1-3) Seminar in environmental science.
510. *Silviculture (3) II Principles and technical procedures for reproducing, planting, and tending forest crops, with reference to watershed, economic, and aesthetic considerations.


520. *Photogrammetry (1) II 1990-91 Aerial photographic planning for natural resource management; stereoscopic principles applied to planimetric and topographic mapping. 3L, P or CR 522.

522. *Photointerpretation (2) II Reading and interpretation of aerial photographs; natural resource inventory from aerial photographs; remote sensing techniques. 1R, 3L.


531. Dryland Forest Management (3) II 1990-91 Utilization and management of forest resources in dry environments; biophysical and socio-economic issues related to the development of silviculture, and other land uses. P. 6 units of upper-division watershed management.

532. Agroforestry (3) I 1989-90 Ecological and socioeconomic factors related to the planning and implementation of agroforestry systems. P. 6 units of upper-division watershed management.


534. Reforestation and Plantation Management (3) I 1990-91 Tree nursery and forest plantation establishment and management, with emphasis on dryland ecosystems. P. 6 units of upper-division watershed management.

535. Water Management in Dryland Ecosystems (3) I Hydrologic principles as applied to arid and semiarid ecosystems with water management applications in dryland resources management. A.E., 539, S.W. 201.

536. Urban Forestry (2) II 1989-90 Principles and practices of urban forestry, including vegetation structure and function, inventory, and evaluation techniques, and planning and management approaches. (Identical with L.R. 536).

545. Systems Analysis in Watershed Management (3) II 1990-91 Application of hydrologic modeling and system analysis for optimizing management of watersheds. P. 460, 462.


562. *Watershed Management (3) II Evaluating hydrologic impacts of management activities on watersheds to include silviculture, range, mining, and recreation use. P. Geos. 100a; S.W. 200; 201; Math. 160.


564a-564b. *Introduction to Dendrochronology (3-3) (Identical with Geos. 564a-564b).

565. Hydrochemistry (3) II 1989-90 (Identical with S.W. 565).


581. *Simulation of Renewable Natural Resources (3) II Simulation of management impacts for multi-resource decision-making, including biologic, economic, and social factors. 2R, 3L. P. 430.

587. *Forestry in Arid Environments (4) S Management of forest lands and other forest resources in developing nations. Designed for中级-level and upper-level resource professionals from developing nations. Field trip. Fee.


595. Colloquium a. Non Point Source Pollution from Watersheds (3) II P. 460.

596. *Dendroclimatology (3) II 1990-91 (Identical with Geos. 596).

597. Seminar a. Watershed Management (1-2) [Rpt.] I II

Wildlife, Fisheries and Recreation Resources

William W. Shaw, Program Leader

Wildlife and Fisheries Science (WFSC)

Russian and Slavic Languages (RUS)

Modern Languages Building, Room 340
(602) 621-7341

Professors John Garrard, Joe Malik, Jr., Assistant Professor Margaret Gibson, Hett Adele Barker, Alexander Dunkel, Detbnta t, Bob Roberts

The Department of Russian and Slavic Languages offers a diversified and balanced program of study including courses in literature, grammar, conversation, linguistics, and culture. All literature courses are conducted in Russian by native or near-native speakers. The emphasis is on the acquisition of practical skills as preparation for continued study, research, teaching, government service, and business careers. The program leads to a Master of Arts degree with a major in Russian. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in Russian. Information concerning this degree as preparation 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 16 acceptable units of upper-division work in Russian.

The degree program requires the completion of at least 50 units, 24 of which must be taken in Russian, including 581, 583, and two seminars, all acceptable units of upper-division work in Russian. All graduate teaching assistants must take 579a-579b. With the permission of the head of the department, the remaining units must be selected from appropriate supporting courses in other disciplines. The decision regarding the requirement for a thesis will be made by the department after consideration of the student's academic progress, 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, the student must give satisfactory evidence of proficiency in the use of the Russian language or of the English language applicable.

501a-501b. Russian Stylistics (3-3) Designed to improve the student's practical mastery of understanding Russian at a higher and more mature level. 501a and 501b required field course.

507a-507b. Advanced Russian Conversation (3-3) P. 407b.
be convened with 400-level course.

Poetry (3) Examination of the poetry of Milton and Lermontov. P, 405b.

Russian Drama (3) Examination of the major dramatic works of nineteenth- and nineteenth-century Russian playwrights. P, 405b.


Graduate Education i. Education

Sociology (SOC)

Social Sciences Building, Room 400 621-3531


Associate Professors Douglas J. McDade, Judd, James V. Bokon, Catherine C. Clendaniel, Robert R. Dias, Celestino Fernandez, Neil D. Fligstein, Patricia L. MacCorquodale, Jerry L. Miller, Walter W. Powall

Assistant Professors Roberto M. Fernandez, Debra Friedman, Joseph R. Hamben (Emeritus), Kathleen C. Schwartzman, James Shockey

The department offers programs leading to the master of Arts and the Doctor of Philosophy in sociology with a major in sociology. A brochure describing these programs is available from the department on request.

Potential applicants are urged to include four courses in theory, methodology, and statistics in the undergraduate program. Applicants must submit scores on the aptitude test the Graduate Record Examination and two letters of recommendation. The undergraduate record must show a major grade of "B" or better in sociology and 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 strong undergraduate record, the student will be considered for the Graduate Record Examination. Both quantitative and verbal portions of this test are required. All students are expected to complete three to six units of sociology, including the following courses:

- 500a-500b, 570a-570b, 575; and three to six units of dissertation research. For students who terminate their work at this institution with a M.A. degree, one research paper prepared for 500-level courses must be submitted for students continuing to the Ph.D. program. In addition, a data-analysis paper must be submitted. Both require a final oral examination. There is no language requirement for the M.A.

- 500a: Introduction to the study of the sociology of advanced industrial societies. (Identical with Anth. 586)


- 503: Sociosomatics (3-3) I II Social control of bodily process and structure, including social determinants of health. Both macro- and micro-sociological theory and research literature. P, upper-division standing and 3 units of social science or consent of department before enrolling.

- 504: Sociology of the Southwest (3) I Populations, cultures, and social problems in their regional setting, with emphasis on the southwest. P, 100 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 504, A. In. S. 504, and M.A.S. 504)

- 505: World-System Theory and Research (3-3) I Theory and research on the modern world-system of production.


- 508: Sociological Method and Theory (3-3) I II Approaches to the study of social phenomena. (Identical with Anth. 508, A. In. S. 508, and M.A.S. 508)

- 509: Social Movements and Collective Action (3) I II A sociological examination of the emergence and development of social movements/collective action at both the societal and individual levels. Major theoretical perspectives on social movements/collective action will be reviewed as will recent and classical empirical works in the area. P, permission to graduate program or departmental approval.

- 520: Communication and the Legal Process (3) I (Identical with Comm. 520)

- 522: Comparative Research Methods (3) I II Theories and research regarding large-scale organizations and their relations to the individual and society. P, 9 units of sociology.*

* A major in another social science may substitute for 3 of these units.

525. Intermediate Complex Organizations (3) Basic review of classic and contemporary approaches to the study of complex organizations; formation, development, and internal processes. (Identical with Anth. 525)

528: Cross-National Research Methods (3) I II Introduction to the logic and methods of cross-national social research. (Identical with Pol. 526)

530. Graduate Social Psychology (3) Basic study of social psychological approaches to the study of the individual with particular reference to socialization and the relationship between the individual and the social structure.

534: Kinship and Social Organization (3) I (Identical with Anth. 534)

535: Public Opinion and Voting Behavior (3) I II (Identical with Pol. 535)

536: Social Structure and Personality (3) I II Relationship between the person and the group; social factors in character formation. P, 9 units of sociology.

541: Deviance and Social Control (3) Basic criticism 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

542: Transformation of Agrarian Societies in the Middle East (3) I (Identical with Or. S. 542)

550: Social Stratification (3) I II Theories of social class, caste, and rank; social mobility in contemporary society. (Identical with Anth. 550)

551: Socialization and Stratification (3) I II Theories and research on the processes of social stratification. P, 467...

553: Advanced Problems in Deviant Behavior (3) I II Advanced problems involved in minority groups in terms of race, caste, class, ethnicity, politics, and religion. P, 100 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 553, A. In. S. 553, and M.A.S. 553)

570a-570b, Social Statistics (3-3) 570a: Probability, distributions, estimation and hypothesis testing. 570b: Ordinal least squares regression, generalized least squares regression, structural equation models (path analysis and non-recursive systems).


580: Population Studies (3) I Theory and research in the fields of fertility, mortality, and migration, with emphasis on their relationships to social structure. An original research project is required.

585. Advanced Sociological Theory (3) I Sociological theories as alternative explanations. P, 100 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 586)

586: Comparative Community Development (3) I Principles of social change applied to problems of community development, including analysis of specific programs. P, 6 units of social sciences. (Identical with Anth. 586)

595. Colloquium a. Introduction to Graduate Study (1) I

596. Seminar a. Problems and Problems in Research (1-3) [Rpt.]

b. Graduate Teaching (3-1) II 1990-91 2R, 3L.

c. Advanced Problems in Deviant Behavior (1-3) II
**Soil and Water Science (SW)**

Shantz Building, Room 429

(620) 621-1846


Associate Professors David M. Hendricks, Allan D. Matthias

Assistant Professors Alfredo Huete, James R. Simpson

The department offers opportunities for study toward the Master of Science and Doctor of Philosophy degrees with a major in soil and water science. Concentrations for soil and water science are available in soil fertility; soil chemistry, soil physics; soil microbiology; soil conservation; soil classification; water quality; irrigation; water resources development, and revegetation and pollution control in relation to soil, water, and air resources.

Students with adequate undergraduate preparation in chemistry, biology, physics, or other sciences, or biological sciences will be considered for admission to an appropriate degree program. A thesis is normally required, but the requirements for a thesis will be approved by a student who is a senior author of a manuscript published or accepted for publication in a refereed professional journal.

501. Management of Arid Lands and Salt-Affected Soils (3) II Principles and practices of soil, water and crop management under arid and semiarid conditions, the use of diagnostic procedures for evaluating soils and waters, reclamation, and economics of irrigation project development. 2R, 3L. Field Trip, Dutt

505. Chemical Analysis of Soils and Plants (4) II Principles and methods of chemical analysis of soil, plant and biological materials with emphasis on instrumental techniques. 2R, 6L, P. Chem. 322, 323, Phys. 102b, 104b. Hendricks

507.* Hydrology of Unsaturated Media (3) I (Identical with Hydr. 407)

511.* Soil Chemistry (3) I CDT Soil chemical interactions with air, water, and pollutants. P, 200, Chem. 103b, 104b. Bohn

517.* Introduction to Geographic Information Systems (3) II (Identical with R.N.R. 517)

520. Evapotranspiration (3) I Theories and concepts of potential and actual evapotranspiration in arid regions; measurement and estimation methods, and plant growth-evapotranspiration relations. P, Math. 125b, Phys. 102b.

531.* Soil Morphology, Classification and Survey (3) I Theory and practice of describing characteristics of soils, principles of soil classification and the classification systems; methods and applications of soil surveys. 2R, 3L. Field trips. P, 200, 201. Geos. 101a. Post


545. Microbiology of the Rhizosphere (2) II 1990-91 Influence of plant roots on soil microorganisms via the rhizosphere. Interaction between soil organisms and roots and rhizosphere dynamics. P, 435 or Micr. 425. (Identical with Micr. 545)

553.* Remote Sensing in Agriculture (3) II Remote sensing techniques and applications for improved natural resource utilization of soils, water, grasslands, and forest. Fundamental energy-matter interactions that influence the spectral characteristics of vegetation, soil, and water. 2R, 3L. Field trips. P, 330 or Phys. 102b.

561.* Soil and Water Conservation (3) S Consideration of major 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.

565. Hydrochemistry (3) II 1989-90 Solute composition of naturally-occurring waters, chemical reactions affecting the solute content of water, relations and effects of above on water quality; pollution. 3L, P. Chem. 322 or C.E. or 471. (Identical with W.S.M. 565)

570.* Soil Physics (3) II CDT Soil structure and physical properties of soils; properties of soil-water systems, movement and exchange of water and solute. 2R, 6L, P, 200, Phys. 102b, CH, Math. 125a. Warrick

594. Practicum


b. Soil and Water Agricultural Engineering (1) [R.P./L.I.] II (Identical with A.En. 696a)

Southwest Studies

Southwest studies are designed to bring new perspectives to regional subjects through an interdisciplinary approach. Courses on the Southwest are taught through many university departments and programs, including American Indian studies, anthropology, English, geography, history, Latin American studies, linguistics, Mexican American studies, political science, sociology, Spanish and Portuguese, and women's studies. For information, contact the Southwest Center.

Spanish and Portuguese

(SPAN/PORT)

Modern Languages Building, Room 545

(620) 621-3123


The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Spanish. In cooperation with the College of Education, the department offers work leading to the Master of Education degree with a major in Spanish; for information concerning this degree and requirements for Master of Degree in Master Education elsewhere in this catalog, consult the graduate Committee on Medieval Studies. The department also collaborates in a program for the Doctor of Philosophy minor in media studies (see pertinent section of this catalog). Finally, it offers doctoral minors in Spanish and Portuguese.

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 thesis of Arts degree with the same major.

**Degrees**

Master of Arts (Major in Spanish): 33 units one of four concentrations.

1. Hispanic literature program leading to terminal: 33 units with equal concentration in Spanish and Spanish-American literature

2. Hispanic literature program with area concentration (terminal): (a) concentration in Spanish literature 24 units in Spanish literature, 9 units in Spanish-American literature. (b) concentration in Spanish-American literature—24 units in Spanish-American literature, 9 units in Spanish literature.

3. Spanish language and linguistics: 9 units pedagogy, 9 units of linguistics, 6 units of language, and 9 units of literature.

4. Hispanic studies (available in Graduate Summer School Only): 21 units of Hispanic literature and no more than 12 units for supporting fields.

Doctor of Philosophy (Major in Spanish): 3 units of graduate course work beyond the literature arts in addition to 18 units of dissertation credits and 15 units in the minor field. New students must pass a qualifying examination in Spanish and Spanish-American literature during to the first semester of residency. Students are required to demonstrate knowledge of at least one foreign language other than Spanish at all phase-year level of proficiency. All students must pass a comprehensive preliminary examination once course work is completed. Each candidate will write and defend a doctoral dissertation making an original contribution to human knowledge.

Spanish (SPAN)

501. Literary Theory and Criticism (3) I 1990-91 Historical survey of theoretical writings on literature, with their implications for practical criticism.


503. Introduction to Medieval Studies (3) I 1989-90 Historical, social, and cultural context as background for the analysis of medieval Hispanic letters.

504. Thirteenth Century Spanish Literature (3) II 1990-91 Spain, 9th to 12th centuries; 6 units. P, 503.

505.* Advanced Composition and Conversational Practice (3) I and II Study and practice in formal discourse and expository writing. P, 520.

506. Fifteenth Century Spanish Literature (3) I 1990-91 Traditional courtly and satirical literature; the Celestina. P, 503.

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Spanish. In cooperation with the College of Education, the department offers work leading to the Master of Education degree with a major in Spanish; for information concerning this degree and requirements for Master of Degree in Master Education elsewhere in this catalog, consult the graduate Committee on Medieval Studies. The department also collaborates in a program for the Doctor of Philosophy minor in media studies (see pertinent section of this catalog). Finally, it offers doctoral minors in Spanish and Portuguese.

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 thesis of Arts degree with the same major.
A thesis is not required, but up to 6 units be approved by writing one.

The Master of Science degree, at least 18
30 units must be taken within the depart-
ment. For further information, consult the
department.

Sampling Theory and Methods (3) II
duction to planning, execution, and anal-
y of surveys, methods of sampling, estima-
tion of population values, estimation of
rpling error and efficiency of methods. P.
course in statistics.

Nonparametric Statistics (3) I Distribu-
tional free statistics, chi-square tests, related
spes, independent samples, correlations,
 of significance, confidence bands. P. one
 course in statistics.

Theory of Probability (3) I (Identical
with Math. 504)

Statistics for the Medical Sciences (4) I
radi and nonparametric one- and two-
procedure statistics; ANOVA designs; linear
regression; multiple regression, bioassay, probit anal-
ysis, and contingency tables. 3R, 3L. Not open
jors. P. two semesters of calculus. (Identifi-
with Math. 515)

Theory of Statistics (3) II (Identical with
Math. 505)

Applied Stochastic Processes (3) II Antithetical
with Math. 568)

be covered with 400-level course.

5. Seminar

a. Research Methods (1-4) [Rpt./6 units] II

b. Linear Regression Analysis (3) I General
interpretation of models, computer printouts and effects of violations of

c. Applied Multivariate Analysis (3) II Con-
vention of multivariate statistical analyses, putting emphasis on applications, interpretation of
computer output, and discrimination of violations

d. Applied Time Series Analysis (3) I Thoats used in time series analysis, withphasis on applications, including computer
alysis of data and consideration of violations

A thesis is not required, but up to 6 units
be approved by writing one.

The Master of Science degree, at least 18
30 units must be taken within the depart-
ment. For further information, consult the
department.

Sampling Theory and Methods (3) II
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y of surveys, methods of sampling, estima-
tion of population values, estimation of
rpling error and efficiency of methods. P.
course in statistics.

Nonparametric Statistics (3) I Distribu-
tional free statistics, chi-square tests, related
spes, independent samples, correlations,
 of significance, confidence bands. P. one
 course in statistics.

Theory of Probability (3) I (Identical
with Math. 504)

Statistics for the Medical Sciences (4) I
radi and nonparametric one- and two-
procedure statistics; ANOVA designs; linear
regression; multiple regression, bioassay, probit anal-
ysis, and contingency tables. 3R, 3L. Not open
jors. P. two semesters of calculus. (Identifi-
with Math. 515)

Theory of Statistics (3) II (Identical with
Math. 505)

Applied Stochastic Processes (3) II Antithetical
with Math. 568)

be covered with 400-level course.

5. Seminar

a. Research Methods (1-4) [Rpt./6 units] II

b. Linear Regression Analysis (3) I General
interpretation of models, computer printouts and effects of violations of

c. Applied Multivariate Analysis (3) II Con-
vention of multivariate statistical analyses, putting emphasis on applications, interpretation of
computer output, and discrimination of violations

d. Applied Time Series Analysis (3) I Thoats used in time series analysis, withphasis on applications, including computer
alysis of data and consideration of violations
include aggregate production planning, capacity planning, inventory control and flexible manufacturing. P. 321, 330R, 330L.


574. Expert Systems (3) I Building, testing and evaluating expert systems, computer systems. Emulate human and draw conclusions based on incomplete or inaccurate data. Each student will build an expert system using commercially available expert system shells. Prerequisite: 321 with P.

575. Computational Methods for Games, Decisions, and Artificial Intelligence (3) II An introduction to automata, computer representation and optimal solution of games and decision problems. Principles of heuristic programming and machine learning. A programming project is to be selected from areas such as game strategies, graphics, recreational mathematics, and manufacturing simulation. Microcomputer experience is emphasized. P. 270 or C.S.C. 227.

576. Numerical Analysis (3) I An intermediate-level introduction to numerical methods and error analysis for function approximation and interpolation, integration, solution of linear and nonlinear equations, and differential equations. P. Engr. 102, Math. 254, or equivalent skill in PASCAL or FORTRAN.

583. Computer Integrated Manufacturing Systems (3) I Modern manufacturing systems with emphasis on information requirements and data management. Includes CAD, CAM, CAPP, real-time scheduling, networking and system justification.

584. Manufacturing Automation (3) II Current topics in hardware for automation, selecting and implementing robots, part orientation, computer vision, automated warehousing and material handling, programmable controllers, NC machining, on-line computer control. Laboratory projects.

585. Introduction to Robotics (3) I A study of the principles involved in the operation and design of robots, including homogeneous transformations, kinematics, trajectory selection, dynamics, control and sensing. P. 350.

586. Modeling Manufacturing Systems (3) II An introduction to modeling in hierarchical design, planning, and control of manufacturing systems and their applications. Topics include modeling automated transfer lines, tabular data management, and flexible manufacturing. Systems attention will be given to the performance of manufacturing systems and operational issues such as the role of robots, flexible machines, computers, and material handling systems. P. 321, 340.

601. Experimental Surgery (2) II Experiments in the surgical procedures common necessary in animal experimentation, include aseptic technique, anesthesiology, surgical operations, and care of the postsurgical patient. 1R, 3L. P. 8 units of mammalian anatomy.

630. Immunology (4) II 1990-91 (Identical with Micr. 630) 1989-90 (Identical with Zool. 630)

681. Biostatistical Methods in Microbiology (2) I 1990-91 (Identical with Micr. 681)

695. Colloquium

Teaching and Teacher Education (See Education)

Toxicology (See Pharmacology and Toxicology, College of Pharmacy)

Urban Planning (See Planning)

Veterinary Science (VSC)

Pharmacy-Microbiology Building, Room 202 (602) 621-4466


Associate Professors Ronald W. Hillwig, Lynn A. Joens, J. Glenn Songer

No advanced degree is offered in veterinary science. Cooperative arrangements may be made with the departments of Entomology, Ecology and Evolutionary Biology, or Microbiology and Immunology for students pursuing advanced degrees in these areas. Students majoring in other disciplines may elect veterinary science as a doctoral minor with the approval of the major department.

500a-500b. Animal Anatomy and Physiology (3-3) Physiology, gross and comparative anatomy. 500a: Nervous, musculoskeletal, immune, hemolymphatic, circulatory, and renal systems. 500b: Respiratory, digestive, endocrine and reproductive systems. 500a is not prerequisite to 500b. P. Ecol. 181, 182; Chem. 243a; Math. 117R/113R.

503R. Biology of Animal Parasites (3) I Biology of host-parasite relationships with emphasis on parasites of veterinary and human importance. Parasite morphology and physiology, life cycles, epidemiology, pathogenesis and zoonotic potential. P. 8 units of biology or microbiology. (Identical with Ento. 503R, Ecol. 503R, Pharmacology and Toxicology, College of Pharmacy)

503L. Parasitology Laboratory (1) I Parasite morphology and diagnostic laboratory techniques. P. 9 units of ecology or microbiology. CR, 403R. (Identical with Ecol. 503L, Ento. 503L and Micr. 503L)

505. Animal Diseases (3) I Integration of management, husbandry, and preventive veterinary medicine, as related to animal diseases.

520R. Pathogenetic Bacteriology (3) II (Identical with Micr. 520R)

520L. Pathogenetic Bacteriology Laboratory (2) II (Identical with Micr. 520L)

523R. General Pathology (3) II Pathogene pathopharmacology and morphologic changes in human and animal diseases. P. Micr. 43 (Identical with Micr. 523R and Tox. 523R)

523L. General Pathology Laboratory (1) II Gross and histologic changes occurring in tissues and organs in selected human and animal diseases and disease processes. P. or 423R. (Identical with Micr. 523L and Tox. 523L).
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- Family & Consumer Resources
- Finance
- Food Science
- Foundations of Education
- French
- Genetics
- Geography
- Geological Engineering
- Geosciences
- German
- Health Education
- Higher Education
- History
- Home Economics Education
- Horticulture
- Hydrology
- Industrial Engineering
- Irrigation Engineering
- Journalism
- Landscape Architecture
- Latin American Studies
- Law
- Library Science
- Linguistics
- Management & Policy
- Management Information Systems
- Marketing
- Materials Science & Engineering
- Mathematics
- Medicine
- Mechanical Engineering
- Microbiology
- Microbiology & Immunology
- Mineral Economics
- Mining Engineering
- Molecular & Cellular Biology
- (Music) Composition
- Music Education
- (Music) Performance
- Music Theory
- Musicology
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- Nuclear Engineering
- Nursing
- Nutritional Sciences
- Optical Sciences
- Oriental Studies
- Pharmaceutical Sciences
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- Sociology
- Soil and Water Science
- Spanish
- Special Education
- Speech & Hearing Sciences
- Statistics
- Systems Engineering
- Systems and Industrial Engineering
- Toxicology
- Water Resources Administration
- Watershed Management
- Wildlife & Fisheries
- Zoology
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- Scholarships and Financial Aid
  Write: Office of Student Financial Aid
- Summer Session
  Write: Summer Session

For Further Information On:

- Applications to the Graduate College
  Write: Graduate College Admissions Office
- Degree Programs
  Write: Head of particular department
- Financial Assistance
  Write: Director of Student Financial Aid
- Housing Facilities
  Write: Director of Residence Life
- Medical Facilities
  Write: Director of the Student Health Service
- Certification for Teachers
  Write: Dean of the College of Education
- Part-Time Employment
  Write: Career and Placement Services
- Transcripts
  Write: The Registrar

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