All colleges and departments establish certain academic requirements which must be met before a degree is granted. These requirements concern such things as curricula and courses, majors and minors, and campus residence. Advisers, directors, department heads, and deans are available to help the student understand and arrange to meet these requirements, but the student is responsible for fulfilling them. At the end of a student's course of study, if requirements for graduation have not been satisfied, the degree will not be granted. For this reason it is important for each student to be acquainted and remain currently informed about all regulations and to be responsible for completing requirements. Courses, programs, and requirements described in the catalog may be suspended, deleted, restricted, supplemented, or changed in any other manner at any time at the sole discretion of the University and the Arizona Board of Regents. The catalog does not establish a contractual relationship but it summarizes the total requirements which the student must presently meet before qualifying for a faculty recommendation to the Arizona Board of Regents 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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Announcements in this catalog concerning regulations, fees, curricula, or other matters, are subject to change without notice. Inquiries regarding admission to the Graduate College should be addressed to:

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

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College of Agriculture—Schools: School of Family and Consumer Resources (with divisions in Family Studies; Educational and Professional Studies; and Merchandising, Consumer Studies and Design); School of Renewable Natural Resources (with programs of Landscape Resources; Range Resources; Watershed Resources; Wildlife and Fisheries Resources). Departments of: Agricultural and Biosystems Engineering; Agricultural Economics; Agricultural Education; 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; East Asian Studies, Ecology and Evolutionary Biology; English; French and Italian; Geography and Regional Development; Geosciences; German; History; Journalism; Linguistics; Mathematics; Media Arts; Near Eastern Studies; Philosophy; Physics; Planetary Sciences; Political Science; Psychology; Russian and Slavic Languages; Sociology; Spanish and Portuguese; Speech and Hearing Sciences; Statistics; Theatre Arts. University Departments of: Biochemistry; Microbiology and Immunology; Molecular and Cellular Biology. Committees on: African-American Studies; Critical Languages; Dance; Judaic Studies; Mexican American Studies; Religious Studies; Russian and Soviet Studies; Women's Studies. Program: Humanities.

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

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. Committee on: Biomedical Engineering.

College of Law

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

College of Nursing

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

School of Health-Related Professions—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; Biophysics; Cancer Biology; Cognitive Science; Comparative Literature and Literary Theory; Environment and Behavior; Epidemiology; Genetics; Gerontology; History and Philosophy of Science; Latin American Studies; Medieval Studies; Neuroscience; Nutritional Sciences; Optical Sciences; Pharmacology and Toxicology; Physiological Sciences; Planning; Remote Sensing, Second Language Acquisition and Teaching.

General Department—School of Military Science, Naval Science, and Military Aerospace Studies.

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

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:

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<td>a.b.e</td>
<td>agricultural &amp; bio-systems engineering</td>
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<tr>
<td>a.b.t</td>
<td>agricultural &amp; bio-systems technology</td>
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<td>a.e.c</td>
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<td>m.s.e.</td>
<td>materials science and engineering</td>
</tr>
<tr>
<td>math.</td>
<td>mathematics</td>
</tr>
<tr>
<td>med.</td>
<td>medicine (interdepartmental)</td>
</tr>
<tr>
<td>med.t.</td>
<td>medical technology</td>
</tr>
<tr>
<td>micr.</td>
<td>microbiology and immunology</td>
</tr>
<tr>
<td>mktg.</td>
<td>marketing</td>
</tr>
<tr>
<td>m.l.s.</td>
<td>military studies</td>
</tr>
<tr>
<td>mn.e.</td>
<td>mining engineering</td>
</tr>
<tr>
<td>mn.ec.</td>
<td>mineral economics</td>
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<tr>
<td>mus.</td>
<td>music</td>
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<tr>
<td>musi.</td>
<td>music (perfor-mance studies)</td>
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<td>n.a.e.</td>
<td>nuclear and energy engineering</td>
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<td>N.E.S.</td>
<td>Near Eastern studies</td>
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<td>n.s.</td>
<td>naval science</td>
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<td>neur.</td>
<td>neurology</td>
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<td>nursing</td>
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<tr>
<td>o.sh.</td>
<td>occupational safety and health</td>
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<tr>
<td>ob.g.</td>
<td>obstetrics and gynecology</td>
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<tr>
<td>opt.</td>
<td>optometry</td>
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<td>optical sciences</td>
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<td>pool.</td>
<td>pharmacology and toxicology</td>
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<td>ph.pr.</td>
<td>pharmacy practice</td>
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<td>pharmaceutical sciences</td>
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<tr>
<td>phcl.</td>
<td>pharmacology (College of Medicine)</td>
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<td>phi.</td>
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<td>p.l.p.</td>
<td>plant pathology</td>
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<tr>
<td>p.s.</td>
<td>plant sciences</td>
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<tr>
<td>pl.g.</td>
<td>planning and governance</td>
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<tr>
<td>pol.</td>
<td>political science</td>
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<td>Port.</td>
<td>Portuguese</td>
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<td>psychology</td>
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<td>p.y.</td>
<td>planetary sciences</td>
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<tr>
<td>r.n.r.</td>
<td>renewable natural resources</td>
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<td>R.S.s.</td>
<td>Russian and Slavic studies</td>
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<tr>
<td>ra.m.</td>
<td>range management</td>
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<td>remote oncology</td>
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<tr>
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<td>Russian and Slavic languages</td>
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<tr>
<td>s.e.r.</td>
<td>special education and rehabilitation</td>
</tr>
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<td>s.i.e.</td>
<td>systems and industrial engineering</td>
</tr>
<tr>
<td>s.w.</td>
<td>soil and water science</td>
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<tr>
<td>soc.</td>
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<td>speech and hearing sciences</td>
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<td>Span.</td>
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<td>statistics</td>
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<td>surg.</td>
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<tr>
<td>theater arts</td>
<td>teleporting and teacher education</td>
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<td>tox.</td>
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<tr>
<td>v.sc.</td>
<td>veterinary science</td>
</tr>
<tr>
<td>w.f.sc.</td>
<td>wildlife and fisheries science</td>
</tr>
<tr>
<td>w.s.</td>
<td>wildlife studies</td>
</tr>
<tr>
<td>w.s.m.</td>
<td>watershed management</td>
</tr>
</tbody>
</table>
# Graduate Calendar

**NOTE:** At the time this catalog was being edited, major revisions of procedure were being undertaken in the Graduate Degree Check Office. Current deadline information is available in Administration 322.

## First Semester

<table>
<thead>
<tr>
<th>1991-92</th>
<th>1992-93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>Aug. 22 Th</td>
</tr>
<tr>
<td>Last day to register for credit, to add courses, and to change from no credit to credit</td>
<td>Aug. 29 Th</td>
</tr>
<tr>
<td>Labor Day—No classes</td>
<td>Sept. 2 M</td>
</tr>
<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Sept. 18 W</td>
</tr>
<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Oct. 30 W</td>
</tr>
<tr>
<td>Veterans' Day—No classes</td>
<td>Nov. 11 M</td>
</tr>
<tr>
<td>Thanksgiving recess</td>
<td>Nov. 28-Dec. 1 Th-Su</td>
</tr>
<tr>
<td>Class and laboratory sessions end</td>
<td>Dec. 11 W</td>
</tr>
<tr>
<td>Semester examinations begin</td>
<td>Dec. 13 F</td>
</tr>
<tr>
<td>Semester examinations end</td>
<td>Dec. 20 F</td>
</tr>
<tr>
<td>Commencement</td>
<td>Dec. 21 Sa</td>
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</table>

## Second Semester

<table>
<thead>
<tr>
<th>1991-92</th>
<th>1992-93</th>
</tr>
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<tbody>
<tr>
<td>Classes begin</td>
<td>Jan. 15 W</td>
</tr>
<tr>
<td>M. L. King Holiday—No classes</td>
<td>Jan. 20 M</td>
</tr>
<tr>
<td>Last day to register for credit, to add courses, and to change from no credit to credit</td>
<td>Jan. 23 Th</td>
</tr>
<tr>
<td>Last day to drop with deletion of course from record</td>
<td>Feb. 11 Tu</td>
</tr>
<tr>
<td>Spring recess</td>
<td>Mar. 14-22 Sa-Su</td>
</tr>
<tr>
<td>Last day to drop courses and to change from credit to no credit</td>
<td>Mar. 31 Tu</td>
</tr>
<tr>
<td>Class and laboratory sessions end</td>
<td>May 6 W</td>
</tr>
<tr>
<td>Semester examinations begin</td>
<td>May 8 F</td>
</tr>
<tr>
<td>Semester examinations end</td>
<td>May 15 F</td>
</tr>
<tr>
<td>Commencement</td>
<td>May 16 Sa</td>
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## Summer Sessions

<table>
<thead>
<tr>
<th>1992</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presession</td>
<td>May 18 M</td>
</tr>
<tr>
<td>Memorial Day Holiday—No classes</td>
<td>May 25 M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>June 6 Sa</td>
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</tbody>
</table>

### First Summer Session

<table>
<thead>
<tr>
<th>1992</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>June 8 M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>July 9 Th</td>
</tr>
</tbody>
</table>

### Second Summer Session

<table>
<thead>
<tr>
<th>1992</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes begin</td>
<td>July 13 M</td>
</tr>
<tr>
<td>Last day of classes and final examination day</td>
<td>Aug. 12 W</td>
</tr>
</tbody>
</table>
Arizona Board of Regents

Ex Officio

Pete Symington .................................. Governor of Arizona
C. Diane Bishop .................................. State Superintendent of Public Instruction

Appointed

Danny Siciliano .................................. May, 1991
Edith S. Westlander, Ph.D. .................. January, 1992
Herman Chanen .................................. January, 1992
Donald Pitt, J.D. .................................. January, 1994
Esther N. Capin, M.Ed. .................... January, 1994
Andrew Hubner, M.S. ....................... January, 1996
Douglas J. Well .................................. January, 1996
Art Chapa, J.D. .................................. January, 1998
Eddie Basha .................................. January, 1998

University Administration

Administrative Officers

(Year of first University appointment in parentheses after each name)

Manuel T. Pacheco (1991), President of the University
B.A., 1962, New Mexico Highlands University; University de Montpellier; M.A., 1966, Ph.D., 1969, Ohio State University

Henry Koffler (1982), President Emeritus
B.S., 1943, University of Arizona; M.S., 1944, Ph.D., 1947, University of Wisconsin; D.Sc., 1977, Purdue University; LL.D., 1981, Amherst College; D.Sc., 1981, University of Arizona

John P. Schaefler (1960-85), President Emeritus
B.S., 1955, Polytechnic Institute of Brooklyn; Ph.D., 1958, University of Illinois

Jack R. Cole (1957), Senior Vice President for Academic Affairs and Provost
B.S., 1953, University of Arizona; Ph.D., 1957, University of Minnesota

Joel D. Valdez (1980) Vice President for Business Affairs
B.S., 1957, University of Arizona

Allan Beige! (1970), Vice President for University Affairs
B.A., 1961, Harvard College; M.D., 1965, Albert Einstein College of Medicine

Herman Koffler (1982), President Emeritus
B.S., 1943, University of Arizona; M.S., 1944, Ph.D., 1947, University of Wisconsin; D.Sc., 1977, Purdue University; LL.D., 1981, Amherst College; D.Sc., 1981, University of Arizona

John P. Schaefler (1960-85), President Emeritus
B.S., 1955, Polytechnic Institute of Brooklyn; Ph.D., 1958, University of Illinois

Dudley B. Woodard, Jr. (1963), Vice President for Student Affairs

James E. Delen (1987), Provost for Medical Affairs
B.S., 1955, Washington State University; M.A., 1966, University of Washington; M.S., 1972, Harvard School of Public Health

Holly M. Smith (1983), Provost for Academic Affairs

Albert B. Weaver (1958-83), Executive Vice President for Student Affairs
B.A., 1940, University of Michigan; M.S., 1941, University of Idaho; Ph.D., 1952, University of Chicago

Richard M. Edwards (1959-83), Vice President for Student Affairs
B.S., 1963, Drake University; M.A., 1965, Ph.D., 1969, University of Nebraska

Arno Richard Kassander (1954-82), Vice President Emeritus for Research
B.A., 1941, D.S.C., 1971, Amherst College; M.S., 1943, University of Oklahoma; Ph.D.,1950, Iowa State College

Graduate College Officers

Michael A. Cusnowich (1969), Vice President for Research and Dean of the Graduate College
B.S., 1955, South Dakota State College; Ph.D., 1958, University of Minnesota

Herbert Dawson Rhodes (1943), Dean Emeritus of the Graduate College
Ph.D., 1948, Ohio State University

Martha W. Gilliland (1990), Vice Dean of the Graduate College
Ph.D., 1963, University of Arizona

Adeia A. Allen (1968), Associate Dean of the Graduate College
Ph.D., 1972, University of Arizona

Curtis Bradford Merritt (1949), Associate Dean Emeritus of the Graduate College
Ph.D., 1955, University of Arizona

Glenn R. Smith (1982), Associate Dean of the Graduate College
Ph.D., 1955, University of Arizona

Deans

J. Lyle Bootman (1978), Dean, College of Pharmacy; B.S., 1974, University of Arizona; M.S., 1976, Ph.D., 1978, University of Minnesota

Willis R. Brewer (1949-83), Dean Emeritus, College of Pharmacy; B.S., 1957, South Dakota State College; Ph.D., 1963, University of Minnesota

B.A., 1958, Stanford University; B.Arch., 1959, University of Utah; M.Arch., 1961, University of Pennsylvania

Robert Leslie Hull (1964), Dean Emeritus, College of Fine Arts; B.Mus., M.Mus., 1941, University of Rochester; Ph.D., 1945, Cornell University

Annette Kodolny (1988), Dean, Faculty of Humanities, College of Arts and Sciences; B.A., 1962, Brooklyn College (CUNY); Ph.D., 1969, University of California, Berkeley

Luan L. Krager (1973), Dean of Students; B.A., 1976, Midland Lutheran College; M.A., 1977, Ph.D., 1987, University of Nebraska

Edgar J. McCullough, Jr. (1957), Dean, Faculty of Science, College of Arts and Sciences; A.B., 1953, M.S., 1955, University of Chicago; Ph.D., 1965, University of Arizona

Darrel S. Metcalfe (1958), Dean Emeritus, College of Agriculture, B.S., 1940, University of Wisconsin; M.S., 1942, Kansas State College; Ph.D., 1952, Iowa State College

Harold E. Myers (1956), Dean Emeritus, College of Agriculture; B.S., 1928, Kansas State University; M.S., 1923, University of Illinois; Ph.D., 1937, University of Missouri

L. Claire Parsons (1987), Dean, College of Nursing; B.S., 1954, Northwestern State College; M.S., 1964, University of Houston; M.S.N., 1965, University of Arizona

F. Robert Paulsen (1964), Dean Emeritus, College of Education; B.S., 1947, Utah State University; M.S., 1948, Ed.D., 1956, University of Utah

Herbert D. Rhodes (1943-77), Dean Emeritus, Graduate College; B.S., 1935; M.S., 1936, University of Arizona; Ph.D., 1939, University of Illinois

Eugene J. T. Sander (1987), Dean, College of Agriculture; B.S., 1957, University of Minnesota; M.S., 1959, Ph.D., 1965, Cornell University

Lee Sigelman (1987), Dean, Faculty of Social and Behavioral Sciences, College of Arts and Sciences; B.A., 1967, Carleton College, M.A., 1971, Ph.D., 1973, Vanderbilt University

Ernest T. Smardon (1988), Dean, College of Engineering and Public Administration; B.S., 1951, M.S., 1956, Ph.D., 1959, University of Missouri

Kenneth R. Smith (1980), Dean, College of Business and Public Administration; B.A., 1964, University of Washington; Ph.D., 1968, Northwestern University

Gladye E. Sorensen (1958), Dean Emerita, College of Nursing; B.S., 1945, University of Nebraska; M.S., 1951, University of Colorado; Ed.D., 1965, Columbia University

Robert S. Slob (1942-44; 1946-83), Dean Emeritus of Students; B.A., 1942, M.A., 1950, University of Arizona


Patricia Van Metre (1979), Acting Dean, Faculty of Fine Arts, College of Arts and Sciences; B.S., 1953; M.Ed., 1963, Ph.D., 1973, University of Arizona

Graduate Council

Adeia A. Allen, Associate Dean of the Graduate College
Diana B. Archangeli, Associate Professor of Linguistics
Thomas Baiss, Associate Professor of Aerospace and Mechanical Engineering
John Bergan, Professor of Educational Foundations and Administration
Hermann K. Bleibtreu, Professor of Anthropology
Michael A. Cusnovich, Vice President for Research and Dean of the Graduate College
Roger Bierbrodt, Professor of English
Duane L. Dietrich, Associate Professor of Systems and Industrial Engineering
Uwe Fink, Professor of Planetary Sciences
Barry Gangop, Professor of Nuclear and Energy Engineering
Martha W. Gilliland, Vice Dean of the Graduate College
Raphael P. Gruener, Director of Graduate Interdisciplinary Programs
Roy A. Johnson, Professor of Music
Noel D. Matkin, Professor of Speech and Hearing Sciences
Michael Meyersohn, Professor of Pharmaceutical Sciences
John D. Palm, Associate Professor of Pharmacy
Jeanne E. Pemberton, Associate Professor of Chemistry
Kenneth Peplon, Student Member
Virginia Richardson, Associate Professor of Teaching and Teacher Education
Eliau Rivero, Professor of Spanish and Portuguese
Glenn R. Smith, Associate Dean of the Graduate College
Howard Smith, Student Member
Spencer R. Titley, Professor of Geosciences
Melanie Wollendorf, Associate Professor of Marketing
Arthur Warrick, Professor of Soil and Water Sciences

Committee on Graduate Study

(Date in parentheses after each name denotes expiration of term)

Jay D. Angeline (1993), Professor of Anatomy
Robert C. Angus (1994), Professor of Agricultural Economics
Julie E. Anson (1993), Professor of Philosophy
Harold S. Arkowitz (1993), Associate Professor of Psychology
Ronald G. Askin (1994), Associate Professor of Systems and Industrial Engineering
Roger C. Bates (1993), Associate Professor of Hydrology and Water Resources
Michael Berfield (1994), Professor of Chemistry
Robert B. Bates (1993), Professor of Chemistry
Robert B. Bickel (1993), Professor of Psychology
Cari T. Berkhout (1992), Associate Professor of English
Harris Bernstein (1994), Professor of Microbiology and Immunology
James Blanchard (1994), Professor of Pharmaceutical Sciences
Hermann K. Bleibtreu (1994), Professor of Anthropology
Anovitz, Lawrence M., Assistant Professor of Geography
Anthony, James R., Professor Emeritus of Music
Anthony, John W., Professor Emeritus of Geosciences
Antia, Shrin D., Associate Professor of Special Education and Rehabilitation
Apostol, H. Vasken, Professor of Molecular and Cellular Biology and of Pharmacology
Appleton, Christopher P., Assistant Professor of Astronomy
Aquino, Nicholas, Associate Professor of Management Information Systems
Arabyan, Ara, Assistant Professor of Aerospace and Mechanical Engineering
Arbas, Edmund A., Assistant Professor in the Neurobiology Division of the Arizona Research Laboratories and in Physiology
Archangelii, Diana B., Associate Professor of Linguistics
Area, Charles E., Professor of Law
Arlew, Robert A., Associate Professor of French and Italian
Arkowitz, Harold S., Associate Professor of Psychology
Armaiti, Sonih, Assistant Professor of Civil Engineering and Engineering Mechanics
Armstrong, Neil R., Associate Professor of Chemistry
Arnett, W. David, Professor of Physics and Astronomy
Arnold, Robert G., Assistant Professor of Civil Engineering and Engineering Mechanics
Aserer, Mark L., Professor of Law
Asil, Daniel L., Associate Professor of Music
Askin, Ronald G., Associate Professor of Systems and Industrial Engineering
Atkins, Allen B., Assistant Professor of Finance and Real Estate
Atkinson, George H., Professor of Chemistry and of Optical Sciences
Atlan, Peter J., Associate Professor of Family and Community Medicine; Assistant Professor of Psychiatry
Atwater, Anne E., Professor of Exercise and Sport Sciences
Atwood, Barbara A., Professor of Law
Atwood, Harry, Associate Professor Emeritus of Radio and Television
Austin, W. E., Professor Emeritus of Classics
Baaback, Barock, Professor of English
Badger, Terry A., Assistant Professor of Nursing
Bagnara, Joseph T., Professor of Anatomy
Baihi, Andrew T., Professor of Systems and Industrial Engineering
Bahr, Randall K., Assistant Professor of Electrical and Computer Engineering
Bailey, Andrew D., Jr., Professor of Accounting and in Management Information Systems
Bailey, Daniel E., Professor of Computer Science
Bailey, Don C., Professor Emeritus of Oriental Studies
Bailey, Mary L., Assistant Professor of Computer Science
Baker, Boyd B., Associate Professor of Exercise and Sport Sciences
Baker, Robert L., Associate Professor Emeritus of Systems and Industrial Engineering
Baker, Susan G., Assistant Professor in the School of Public Administration and Policy
Baker, Victor R., Professor of Geosciences, of Planetary Sciences and in the Lunar and Planetary Laboratory
Bales, Roger C., Assistant Professor of Hydrology and Water Resources
Balas, Thomas R., Associate Professor of Aerospace and Mechanical Engineering
Barford, Calvin R., Associate Professor of Neurology
Bannister, Bryant, Professor of Dendrochronology in the Tree Ring Laboratory
Barbee, Robert A., Professor of Internal Medicine
Barber, William A., Professor of Anatomy
Barbara, Maria J., Assistant Professor of Spanish and Portuguese
Barfield, Michael, Professor of Chemistry
Barnes, Carol A., Professor of Psychology and of Neurology
Barnes, William D., Professor Emeritus of Secondary Education
Barreca, Frank R., Professor Emeritus of Radio and Television and Television Production
Barrett, Bruce R., Professor of Physics
Barrett, Harrison H., Professor of Optical Sciences and of Radiology
Barrett, William B., Professor of Accounting
Barr, Leo L., Professor of Spanish and Portuguese
Baras, Andrew, Assistant Professor of Linguistics
Bartels, Paul G., Professor of Plant Sciences
Bartels, Peter H., Professor of Optical Sciences and of Pathology
Bartlett, Neil R., Professor Emeritus of Psychology
Bartocchio, Bodo, Professor of Agricultural Economics
Barton, Leslie J., Professor of Pediatrics
Bashkin, Stanley, Professor of Physics
Bassett, Randy L., Associate Professor of Hydrology and Water Resources
Basso, Ellen D., Professor of Anthropology
Batchen, Herman E., Professor Emeritus of History
Bates, Robert B., Professor of Chemistry
Bauwens, Eleanor E., Professor of Nursing
Bayles, Kathryn A., Associate Professor of Speech and Hearing Sciences
Bayly, Bruce J., Assistant Professor of Mathematics
Beach, Lee R., Professor of Management and Policy
Beattie, Bruce R., Professor of Agricultural Economics
Becher, Eric A., Associate Professor of Music
Sechel, Robert B., Professor of Psychology
Bechtold, Jill, Assistant Professor in the Steward Observatory and Astronomy
Beck, Jean R., Professor Emeritus of German
Beck, Jonathan, Professor of French and Italian
Beck, Susan L., Assistant Professor of Geosciences
Becker, Stewart, Professor Emeritus of Electrical Engineering
Bedford, Felice L., Assistant Professor of Psychology
Bedrick, A. D., Associate Professor of Pediatrics
Beeker, Ruth Ann, Associate Professor of Elementary Education
Belgel, Allan, Professor of Psychiatry and of Psychology
Bell, Iris R., Assistant Professor of Psychiatry
Benjamin, James B., Assistant Professor of Surgery
Benson, Bryant, Professor of Anatomy
Benson, Carl T., Professor of Mathematics
Bergersen, Albert J., Professor of Sociology
Bergersen, Isla P., Professor of Dance in the School of Music
Berkhout, Carl T., Associate Professor of English
Bernardi, Rosemarie, Associate Professor of Art
Bernath, Peter F., Assistant Professor of Chemistry
Bernays, Elizabeth A., Professor of Entomology
Bernhard, Victor M., Professor of Surgery
Bernstein, Alan E., Associate Professor of History
Bernstein, Gail L., Professor of History
Bernstein, Harris, Professor of Microbiology and Immunology
Berry, James W., Professor Emeritus of Nutrition and Food Science
Bessey, Paul M., Associate Professor of Plant Sciences
Betterton, Eric A., Assistant Professor of Atmospheric Sciences, and in the Institute of Atmospheric Physics
Bickel, William S., Professor of Physics
Biegling, John H., Associate Professor of Astronomy
Bier, Milton, Professor of Engineering and of Microbiology
Bierweg, Gerald O., Professor of Finance and Real Estate
Birgus, Dunbar P., III, Assistant Professor of Materials Science and Engineering
Bishop, Jerold, Associate Professor of Art
Black, John H., Professor of Astronomy
Bianchard, James, Professor of Pharmaceutical Sciences
Blank, Jacqueline J., Assistant Professor of Nursing
Blaise, David E., Associate Professor of Anatomy
Blazquez, Oscar A., Assistant Professor of Family and Consumer Resources
Bleys, Mill J., Professor Emeritus of Elementary Education
Bliek, Erich K., Associate Professor of Finance and Real Estate
Bielbruck, Hermann K., Professor of Anthropology
Biltzer, Leon, Professor Emeritus of Physics
Block, Michael K., Professor of Management and Policy, Economics and in the School of Public Administration and Policy
Bloom, John H., Professor Emeritus of Music
Bloom, John W., Associate Professor of Internal Medicine
Bloom, Paul, Assistant Professor of Psychology
Bliss, Homer E., Associate Professor of Plant Pathology
Boe, John, Professor of Music
Boelts, Jackson G., Associate Professor of Art
Bogart, Fred O., Professor Emeritus of Accounting
Bohn, Hinrich L., Professor of Soil and Water Sciences
Bohmert, Hans J., Professor of Biochemistry; Associate Professor of Molecular and Cellular Biology, and of Plant Science
Bonch-Bruevich, Eugene T., Associate Professor of Oriental Studies and of Geography and Regional Development
Boone, Daniel R., Professor Emeritus of Speech and Hearing Sciences
Bootman, J. Lyle, Professor of Pharmacy Practice
Bootzin, Richard R., Professor of Psychology and of Psychiatry
Borcherding, James, Associate Professor of Sociology
Bos, Candace S., Associate Professor of Special Education and Rehabilitation
Bottaccini, Manfred R., Professor Emeritus of Aerospace and Mechanical Engineering
Bourque, Don, Professor of Nutrition and Food Science, of Biochemistry and of Molecular and Cellular Biology
Bower, George T., Professor of Radiation Oncology, Pharmacology and Toxicology and Molecular and Cellular Biology
Bowen, Don L., Professor Emeritus of Management and Policy
Bowen, Roger, Associate Professor of English
Bowen, Theodore, Professor of Physics and of Radiology
Bowen, Raymond V., Professor Emeritus of Sociology
Bowers, William S., Professor of Entomology
Boyd, William E., Professor of Law
Boyden, Thomas W., Associate Professor of Internal Medicine
Boyer, John T., Professor of Internal Medicine and of Family and Community Medicine
Boynton, William V., Associate Professor of Planetary Sciences and in the Lunar and Planetary Laboratory
Bradon, Carrie J., Assistant Professor of Nursing
Bradley, John M., Associate Professor of Language, Reading and Culture
Bradley, Michael D., Associate Professor of Hydrology and Water Resources
Brainard, Charles J., Professor of Educational Psychology
Brandt, Brenda M., Assistant Professor of Family and Consumer Resources
Brannon, Patay M., Associate Professor of Nutrition and Food Science
Broadfoot, A. Lyle, Senior Research Scientist of Planetary Sciences
Braun, Eldon, Professor of Physiology
Brendel, Klaua, Professor of Pharmacology
Brenner, Robin J., Assistant Professor of Finance and Real Estate
Breasser, Ruben, Professor of Internal Medicine and of Pharmacology
Brettel, Eleanor V., Professor Emerita of Nursing
Breuer, Willis R., Professor Emeritus of Pharmaceutical Sciences and of Pharmacology and Toxicology
Brews, John R., Professor of Electrical and Computer Engineering
Briggs, Maurice M., Professor Emeritus of Finance, Insurance and Real Estate
Brillhart, John D., Professor of Mathematics
Brio, Myosse, Assistant Professor of Mathematics
Brown, Conrine M., Assistant Professor of Finance and Real Estate
Bronstein, Judith, Assistant Professor of Ecology and Evolutionary Biology
Brosh, Henry W., Professor of Psychiatry
Broder, Barry W., Professor Emeritus of History
Broer, Danny L., Associate Professor of Molecular and Cellular Biology and of Biochemistry
Brown, A. Dolores, Professor of Spanish and Portuguese
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GENERAL INFORMATION

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

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

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

ACCOMMODATION OF RELIGIOUS OBSERVANCE AND PRACTICE

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

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

FACILITIES AND SERVICES

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

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

THE ARIZONA CANCER CENTER (1976), a division of The University of Arizona College of Medicine, was established to contribute significantly to research related to the understanding and treatment of cancer. As a National Cancer Institute-
designated comprehensive cancer center, the Arizona Cancer Center conducts research activities that include basic laboratory and clinical research, cancer prevention and control research, professional training and continuing education programs, patient and public education activities and community service and outreach programs. The cancer center facilities and coordinates cancer-related educational programs within the University to provide education and research training opportunities for medical and graduate students.

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

THE ARIZONA CENTER 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 research themes are the modelling, understanding and applicability of nonlinear processes in optics, fluids, neural networks, and random distributed systems with continuing investigations 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, postdoctoral fellows, long- and short-term visitors and sponsors various workshops throughout the year. These activities serve to provide an environment for student and faculty interaction.

THE ARIZONA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT (1951) engages in graduate education, research, and extension. The unit is supported by the University of Arizona, the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute. The facilities and personnel of the unit are available to graduate students who wish to pursue both class work and research programs leading to advanced degrees in fisheries science and wildlife biology. The unit is housed in the School of Renewable Natural Resources.

THE ARIZONA COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT (1973), located in the School of Renewable Natural Resources, is engaged in research to support the natural science program of the National Park Service. In cooperation with the University of Arizona, the unit provides graduate research opportunities and instructional support in a broad array of natural resource problem areas.

THE ARIZONA 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, post-graduate, 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.

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

THE ARIZONA POISON AND DRUG INFORMATION CENTER (1980) is operated by the College of Pharmacy and is located in the Arizona Health Sciences Center Library. The center provides comprehensive poison information and advice on treatment of poisoning to the public on a 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 a focus of remote sensing research in the College of Agriculture. The staff of the center is involved in interdisciplinary remote sensing and computer mapping projects related to agriculture and natural resource management. The center contains equipment for manual analysis of satellite and aircraft imagery and computer systems for digital processing and display of images and maps. These facilities are available to faculty, students and cooperators from outside the University.

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

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

THE 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 in support of the instructional, research, and administrative computing needs of the University. The University's network of shared computers includes a VAXcluster which comprises two 8650's, an 8700, and an 11780. Other mainframes include a Prime 6350, an IBM 3090-300E, and two CONVEX C240 minisupercomputers. CCIT also provides access to nearly 200 IBM PC, PC compatible, and Apple Macintosh microcomputers in labs available to faculty, staff, and students.

The CCIT provides a campus-wide data communications network which supports both central and distributed processors. Access to facilities is available 24 hours a day. Additionally, CCIT provides access to external networks such as BITnet and National Internet which provides access to academic institutions and supercomputer centers across the country. The University is a member of Cornell National Supercomputing Facility's Smart-Node Program and has a local allocation of service units.

Interactive access to CCIT's central computers comes through the IDX-3000, a campus-wide data communications network. Users may access these systems from terminal access centers at various campus locations. Remote access is also provided through the following dial-up numbers: 621-4141 and 621-9600.

CCIT offers many services to assist users in taking advantage of available computing resources. Services include mainframe and microcomputer open access facilities; Computing and Technology Store (CATS) for microcomputers, workstations, peripherals, and software; Courseware Library for Instructional Computing (CICL); a wide variety of training; consulting on the use of the University's computers and various microcomputers; communications and networking between user-owned equipment and the University's systems; computer facility planning and preparation; mainframe and microcomputer training facilities; programming and applications support; dissemination of information through user publications, manuals, and program library documentation; and assistance in user acquisition of computing facilities.

The primary source for information and assistance on computing services and facilities is the CCIT Help Desk (621-HELP). The Help desk is located in Room 218 of the Computer Center Building. Computer users can keep informed of changes in and additions to CCIT services by reading the Computing & Communications News.

THE CENTER FOR 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 sub-
scription. Photographs and archive materials are available through both exhibition and personal print viewing appointments.

THE CENTER FOR MICROCONTAMINATION CONTROL (1984) is located in the Department of Electrical and Computer Engineering. The center conducts fundamental and applied research that will lead to better control of defects in high density logic and memory technology. It is one of 49 centers throughout the country initiated by the National Science Foundation to increase the rate of technology interchange between the academic community and the scientists and engineers of industry. The center sponsors interdisciplinary research in more than six departments in several colleges. In addition, the center maintains a class-10 cleanroom, an equipment test-tower, and equipment for measuring low levels of airborne and surface contamination.

THE CENTER FOR MIDDLE EASTERN STUDIES is engaged in a variety of aspects of research on the modern Middle East. Areas of interest include Afghanistan, Iran, Israel, the Persian Gulf, Egypt, the Fertile Crescent, and Turkey. 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, as well as the University's Egypt Working Group, which promotes research by experts in several disciplines. Including more than 50 faculty members, the center includes representatives of virtually every college at The University of Arizona.

THE CENTER FOR PHARMACEUTICAL ECONOMICS (1989) is an interdisciplinary research and service unit of the College of Pharmacy. The center was established to provide national and international leadership in the application of the economic and administrative sciences in health care and pharmaceutical research, education, and service. The center integrates clinical and economic research to achieve a framework for the economic evaluation of new therapies. Services will include economic/clinical analyses for individual client's needs; training programs for industry representatives, researchers, and practitioners; software programs to analyze cost and benefits of drugs; and the dissemination of information about pharmaceutical issues in managed health care systems.

THE CENTER FOR THE MANAGEMENT OF INFORMATION (CMI). The Center for the Management of Information, partially funded 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 are 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 areas has been established.

THE CENTER FOR THE STUDY OF COMPLEX SYSTEMS, a multidisciplinary unit bringing together local and external researchers, is designed to identify and explore new concepts and features of complex nonlinear systems. It is part of the working areas of science. Recent advances in the understanding of fundamental aspects of nonlinear systems, coupled with progress in computer technology, permit new approaches to heretofore intractable scientific problems in diverse fields: climate; cognitive science; computational theory; elementary particle physics; evolutionary biology; materials and condensed matter science; motor control, robotics and prosthetics; neurobiology; vascular physiology; turbulence; and others. The center sponsors research, visiting scientists, workshops, and colloquia, all aimed at encouraging the development of new approaches to complexity at the interfaces between traditional scientific disciplines such as biology, chemistry, mathematics, and physics.

THE CENTER FOR THE STUDY OF HIGHER EDUCATION (1978) in the College of Education conducts research studies and provides related service activities to meet state and institutional needs, as well as those of national, international and regional governmental units and other organizations. It develops and disseminates information about higher education policy and operation and facilitates the research of faculty members and students. Special research and service projects are provided through university funds and outside support.

THE COOPERATIVE EXTENSION SERVICE (1914) brings information to interested people of Arizona. One of the three divisions of the College of Agriculture, it emphasizes agriculture production and natural resources, family and consumer resources, 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 agent, state and area specialist system with faculty trained in their specialty, and in the practical application of scientific information on farms, ranches and in rural and urban homes. Assistance is provided to target audiences in problem solving, information dissemination and educational programs.

THE DIVISION OF EXTENDED UNIVERSITY AND THE SUMMER SESSION, as an academic division of the University, provides all off-campus 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. Off-campus graduate courses carry university credit, which may be applied toward graduate degree programs. 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.

THE DIVISION OF ECONOMIC AND BUSINESS RESEARCH (1949) is a research and service organization within the College of Business and Public Administration. Its broad objectives are to conduct research relating to business, economics, planning, and public policy; to complement the formal education of students with research experience; and to disseminate information. To achieve its objectives, DEBR builds and maintains regional economic models for applications in forecasting and impact simulation, conducts research on state and local market conditions, analyzes the effects of public policy alternatives, and provides technical assistance for computerized corporate and government planning applications. It publishes the semiannual Arizona Review, the monthly Arizona's Economy, the chart book Arizona's 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.
THE 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, 897 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 Harvill 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.

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

THE 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.

THE 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 benefit to the State of Arizona.

THE ENVIRONMENTAL RESEARCH LABORATORY (1967) conducts research in controlled-environment agriculture (CEA) and aquaculture for intensive food production, in seawater crop irrigation, in biospherics, environmental control systems, 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 special projects as the portrayal of agriculture of the future at the EPCOT Center at Walt Disney World in Florida. ERL has also developed a series of demonstration solar homes at Tucson International Airport, where the laboratory is located. The work in biospherics research is reflected in the development of Biosphere II, a private venture of Space Biosphere Ventures, and in global studies of the greenhouse effect.

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 climate.

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

THE 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 Admini-
istration. It has three broad objectives: (1) to promote research in basic market processes, (2) to sponsor an Entrepreneurial Studies Program, and (3) to provide for business/academic exchange. Research is supported through the recruitment of Karl Eller Chair holders in the disciplines represented in the college. Faculty research fellowships are also available. The Entrepreneurial Studies Program offers both academic courses for students interested in entrepreneurship and practical courses on the development of 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 Study 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 and ancient timbers, the laboratory maintains a variety of specialized equipment and data files containing processed tree-ring chronologies, relevant climatic and hydrologic records, and archaeological tree-ring dates and site information.

THE LATIN AMERICAN AREA CENTER (1974) is a unit of the Faculty of Social and Behavioral Sciences that fosters opportunities for students and researchers in Latin American Studies. In addition to offering undergraduate and graduate programs through its Committee on Latin American Studies, the center is a focal point of Latin American related research undertaken by scholars from every college of the University and whose interests range from medicine to law, from anthropology to ecology, from agriculture to history and from political science to international business. Each year the center engages in a variety of outreach activities: editing and publishing, television and radio programming, curriculum development for the public schools, conferences, lecture and film series, and government funded training programs for Latin American professionals. The center also works with students to arrange internship and study abroad programs designed to enhance career opportunities.

THE LUNAR AND PLANETARY LABORATORY (1960), 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 coinvestigators on space experiments, including Apollo, Mariner, Voyager, and Pioneer spacecraft. Major ground-based research facilities include the University of Arizona telescopes (150 cm, 100 cm, 70 cm aperture reflectors on Mt. Lemmon; 154 cm aperture reflector and 46/71 cm Schmidt camera near Mt. Bigelow; 53 cm reflector on Tumamoc Hill; 220 cm Cassegrain reflector on Kitt Peak; and the multiple-mirror telescope on Mt. Hopkins), a scanning electron microprobe, 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 is host to visitors from other scientific institutions around the world. Graduate research assistantships are available on a selected basis to students planning to study toward the Ph.D. degree with a major in planetary sciences.

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 gems. The museum, a part of the collections of the Department of Geosciences since its establishment, is open to students and the general public.

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

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

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

THE 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 OFFICE OF INTERDISCIPLINARY GRADUATE PROGRAMS. One of the major problems facing higher education is the initiation and development of effective interdisciplinary programs of education and research. The traditional disciplinary structure of the University is being altered in diverse ways, some involving informal cooperation of interested faculty, others resulting in creation of centers, institutes and other organized units. The University of Arizona has responded to these needs by creating a number of interdisciplinary units: the Office of Arid Lands Studies, the Environmental Research Laboratory, the Optical Sciences Center, the Institute for Atmospheric Physics, the Center for Insect Science, and others.

The Office in Interdisciplinary Programs was established as an agency responsible for furthering the development of new activities. The Coordinator of Interdisciplinary Programs works with the Dean of the Graduate College and the Vice President for Research in fostering both educational and research projects.

THE OPTICAL SCIENCES CENTER (1967) is a center for teaching and research in optical physics and engineering. Research areas include electro-optics, femtosecond laser spectroscopy, image formation, image processing, infrared scattering, 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, semiconductor physics and novel structures, 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 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, molecular beam epitaxy (MBE), small-optics shop, student/faculty machine shop, and teaching laboratories. In addition, excellent computing facilities are available for use in both research and teaching 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.

SEMATECH CENTER OF EXCELLENCE FOR CONTAMINATION/DEFECT CONTROL AND ASSESSMENT (1988) is a joint effort by industry and the federal government to reverse a decline in U.S. competitiveness in semiconductors, particularly in the production of integrated circuits. Centers of Excellence established at universities represent SEMATECH's external research arm and are selected based on the quality and relevance of the programs proposed. They will bring graduate students into semiconductor manufacturing and will create a major academic manufacturing research capability. In May 1998, the UA became one of the first five universities selected to become a center of excellence. Engineers working in the center are developing methods for measuring and removing impurities, contamination, and defects that are a major problem for semiconductor manufacturing.

The Department of Electrical and Computer Engineering, home to the SEMATECH Center of Excellence, provides a director that coordinates the efforts of principal investigators from Electrical and Computer Engineering, Materials Science and Engineering, Chemical Engineering, and Systems and Industrial Engineering. Part of the research is being carried out with Sandia National Laboratories in Albuquerque. The technical objectives of the center are threefold: (1) to understand and utilize chemical reactions and charge effects to develop methods and systems for removal of gaseous impurities and particulates from process gases and liquids; (2) to understand and develop control techniques for contaminants and defects originating from vacuum-related processes/equipment; and (3) to understand through test structures the role of specific contaminants in generating defects that limit yield, and to prioritize efforts in contamination/defect reduction. The center transfers technology to SEMATECH through reports, workshops, students, and cooperative research projects.

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 this 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 center is located at 1052 N. Highland Avenue.

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. (1.55-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.

UNIVERSITY LIBRARIES. The University Library system contains almost 7000,000 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, geography, arid lands, Spanish and Latin American language and literature, American agriculture, Southwestern America, Arizona, 20th century photography, history of science, science fiction, and 18th- and 19th-century British and American literature. Through the library the University is a member of the Center for Research Libraries and the Association of Research Libraries. The library is also a member of the AMIGOS Bibliographic Network and through that and other agencies can borrow materials for student and faculty research on interlibrary loan. The Library offers reference service, online searching of computerized data bases, and bibliographic course-related instruction.

The University Library system consists of the Main Library which houses the Central Reference Department, Government Documents, the Media Center, the Map Collection, and the Current Periodicals, Newspapers, and Microforms Room; the Science-Engineering Library; and the following Branch Collections: the Oriental Studies Collection, the Music Collection, the Center for Creative Photography, the Southwest Folklore Center, and Special Collections. Four large but separate library facilities are the College of Law Library, the Architecture Library, the Arizona Health Sciences Center Library, and the Arizona State Museum Library. In addition, several other departmental libraries such as the Division of Economic and Business Research Library, the Steward Observatory Library, the Herbarium, and the Lunar and Planetary Sciences Library have been established to serve special research needs.

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

Government Documents is a depository for U.S. government documents; houses more than a million items.

Medal Center houses all the library's non-book materials except microforms and music tapes and records. The film department was added in 1988.

Map Collection is a depository for USGS maps, houses a fully cataloged collection of more than 200,000 maps on every subject.

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

Science-Engineering Library houses all materials on science and technology; has over 500,000 volumes, almost a million and a half microforms, and displays current issues of its 4500-plus periodicals. It has an online catalog which provides access to its collections.
Music Collection houses the library's collection of 50,000 scores, 15,000 pieces of sheet music and 25,000 recordings. Facilities for listening are provided.

Center for Creative Photography houses the library's archive of over 100 famous 20th century photographers. The Center's collections are internationally known.

Southwest Folklore Center houses musical tapes and manuscript archives of Southwest music and folklore.

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, Turkish, and other Oriental languages; has over 160,000 items.

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

Health Sciences Center Library 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 in the health sciences.

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

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 the masterpieces of the Samuel H. Kress Collection, which include the surviving panels of the Retablo of Ciudad Rodrigo by Fernando Gallego and one of the finest university collections of Renaissance sixteenth- and seventeenth-century art in the United States. Contemporary international painting and sculpture are well represented in the Edward Joseph Gallagher III Memorial Collection; 61 sketches and models by Jacques Lipchitz which comprise one of the largest collections of his work in the world; the C. Leonard Pfeiffer Collection includes American paintings from the 1930s and was the first collection of art donated to the University. An active exhibition and educational program is available throughout the year. The Museum of Art is open to the public on weekdays from nine to five and on Sunday from noon to four. There is no admission fee.

THE UNIVERSITY OF ARIZONA POETRY CENTER, 1216 N. Cherry Avenue. 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 contemporary 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. For information, call 321-7760.

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, the environment and natural history, women's studies, 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 located at 1052 N. Highland Avenue.

THE VIDEOCAMPUS (1972) delivers University of Arizona courses to students in a live interactive mode via broadcast, campus feed, or satellite, and by videotape. Using video technology and other delivery methods, The University of Arizona can serve students anywhere in the world.

The Extended University develops educational programs using distance-learning technologies. Programs now available through VideoCampus include fully accredited undergraduate and graduate courses carrying regular University of Arizona credit; graduate degree programs; courses for individual and professional development; customized courses developed for clients' specific needs; and video conferences on topics such as managerial and technical training, professional development, and office management.

Videotaped courses can be mailed to any location. VideoCampus also uses a live microwave signal to transmit class presentations between the campus and sites in the Tucson area. Courses are also available through The University of Arizona's affiliation with National Technological University and the Association for Media-Based Continuing Education for Engineers.

THE WATER RESOURCES RESEARCH CENTER (1965) is funded by the federal Water Resources Research Act to facilitate water-related research at the three state universities. The State of Arizona also funds the center to transfer relevant information from the State's academic institutions to the Arizona water community. It is part of a national network of centers operating under the guidance of the U.S. Geological Survey which provides access to water data and publications.

The mission of the Water Resources Research Center is to facilitate interdisciplinary research on current water issues and to bring research findings to the attention of potential users.

COOPERATING ORGANIZATIONS

Certain other independent agencies, not administratively a part of the University of Arizona, cooperate closely with the University and provide opportunity for study and research for faculty and qualified graduate students. Several of these are actually located on the University campus, and certain staff members of some also hold University staff appointments.
ARIZONA-SONORA DESERT MUSEUM is a self-supporting, nonprofit institution situated fourteen miles west of the city of Tucson in a saguaro and palo verde landscape of the Sonoran desert. This living indoor and outdoor museum of natural history enables one to gain in a few hours a knowledge of the flora and fauna of the Southwest that would otherwise require many years. Unique habitat groups and other displays of desert animals and plants have been developed at this unusual museum. The museum cooperates with educational institutions at all levels as an outdoor education center and provides laboratory and field space for research in the natural history of Arizona and Sonora, Mexico, with special emphasis on the Sonoran desert common to both states.

ARIZONA HISTORICAL SOCIETY. Organized in 1884 for "the collection and preservation of materials illustrative of the history of Arizona in particular and of the West generally," the Society receives support from the State, and maintains both a historical museum and a research library. The museum and library are located adjoining the University campus and contain 50,000 books, 2,000 manuscript collections, and 250,000 photographs, as well as film and oral history interviews. The manuscript collections are especially rich, with letters, diaries, journals, business records and other documents, many of which are still partially or completely unpublished. State and federal historical records are on microfilm, as are records from Spanish colonial archives. Membership is open to everyone. Museum collections of historical artifacts are available by appointment for study and research.

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

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

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

UNITED STATES GOVERNMENT AGENCIES. A number of agencies of the United States Government, including several divisions of the Agricultural Research Service and the Soil Conservation Service of the United States Department of Agricul-

**1991-92 EXPENSES AND FEES—PER SEMESTER**

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

ARIZONA RESIDENTS:

<table>
<thead>
<tr>
<th>Number of Units</th>
<th>AFAT Fees</th>
<th>Recreation Center Fee</th>
<th>Registration</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$6</td>
<td>$160</td>
<td>$80</td>
<td>$240</td>
</tr>
<tr>
<td>2</td>
<td>$6</td>
<td>$160</td>
<td>$80</td>
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<tr>
<td>3</td>
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<td>$160</td>
<td>$80</td>
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<td>4</td>
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<td>5</td>
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<td>$160</td>
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<td>$240</td>
</tr>
<tr>
<td>6</td>
<td>$6</td>
<td>$160</td>
<td>$80</td>
<td>$240</td>
</tr>
<tr>
<td>7 or more</td>
<td>$6</td>
<td>$160</td>
<td>$80</td>
<td>$240</td>
</tr>
</tbody>
</table>

NONRESIDENTS:

<table>
<thead>
<tr>
<th>Number of Units</th>
<th>AFAT Fees</th>
<th>Recreation Center Fee</th>
<th>Registration</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>3</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>4</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>5</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>6</td>
<td>$3</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
<tr>
<td>7 or more</td>
<td>$6</td>
<td>$25</td>
<td>$200</td>
<td>$250</td>
</tr>
</tbody>
</table>

*Expenditures and fees for 1992-93 were not available at the time of catalog printing.
²The Arizona Financial Aid Trust (AFAT) fee will not be refunded once classes begin.
SUMMARY OF MINIMUM ANNUAL ESTIMATED EXPENSE FOR FULL-TIME CAMPUS STUDENTS, 1990-91

Legal Residents of Arizona:

<table>
<thead>
<tr>
<th>Expense</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration fee</td>
<td>$1,478.00</td>
</tr>
<tr>
<td>AFAT fee</td>
<td>$12.00</td>
</tr>
<tr>
<td>Recreation Center Fee</td>
<td>$50.00</td>
</tr>
<tr>
<td>Residence halls, average rate</td>
<td>$1,536.00</td>
</tr>
<tr>
<td>Meals in university cafeteria</td>
<td>$1,900.00</td>
</tr>
<tr>
<td>Books and supplies</td>
<td>$574.00</td>
</tr>
<tr>
<td>Total minimum annual expense</td>
<td>$5,550.00</td>
</tr>
</tbody>
</table>

Nonresidents of Arizona:

<table>
<thead>
<tr>
<th>Expense</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration fee</td>
<td>$1,478.00</td>
</tr>
<tr>
<td>AFAT fee</td>
<td>$12.00</td>
</tr>
<tr>
<td>Recreation Center fee</td>
<td>$50.00</td>
</tr>
<tr>
<td>Nonresident tuition fee</td>
<td>$5,006.00</td>
</tr>
<tr>
<td>Residence halls, average rate</td>
<td>$1,536.00</td>
</tr>
<tr>
<td>Meals in university cafeteria</td>
<td>$1,900.00</td>
</tr>
<tr>
<td>Books and supplies</td>
<td>$574.00</td>
</tr>
<tr>
<td>Total minimum annual expense</td>
<td>$10,556.00</td>
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</table>

Miscellaneous Expenses:

<table>
<thead>
<tr>
<th>Expense</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application fees to graduate degree program</td>
<td>$25.00</td>
</tr>
<tr>
<td>Application fees to graduate nondegree status</td>
<td>$10.00</td>
</tr>
<tr>
<td>for readmission</td>
<td>$10.00</td>
</tr>
<tr>
<td>Music fee for private lessons, per semester</td>
<td></td>
</tr>
<tr>
<td>1/2 hr. per week</td>
<td>$40.00</td>
</tr>
<tr>
<td>1 hr. per week</td>
<td>$60.00</td>
</tr>
<tr>
<td>Late registration fee (any time after the scheduled 2-day period)</td>
<td>$25.00</td>
</tr>
<tr>
<td>Foreign student language examination fee</td>
<td>$10.00</td>
</tr>
<tr>
<td>Application for degree candidacy fee</td>
<td>$10.00</td>
</tr>
<tr>
<td>Processing fee (thesis or dissertation)</td>
<td>$15.00</td>
</tr>
<tr>
<td>Dissertation microfilm fee</td>
<td>$25.00</td>
</tr>
<tr>
<td>Caps and gowns are purchased for $16.00 or $19.00, depending upon degree. Hoods are purchased for $15.50 or $18.00, depending upon degree. Transcript fee</td>
<td>$3.00</td>
</tr>
<tr>
<td>Transcript fee</td>
<td>$3.00</td>
</tr>
<tr>
<td>(Instantaneous service is $4.00)</td>
<td>----------</td>
</tr>
</tbody>
</table>

1 The registration fee for seven or more units. Students taking fewer than seven units pay $90.00 per unit per semester beginning with the 1991-92 academic year.
2 Average residence hall rates range from $1,060.00 to $1,920.00 per student per year and are subject to increase for the 1991-92 and 1992-93 academic years.
3 The nonresident tuition for 12 or more units. The nonresident tuition is waived for graduate assistants currently on appointment.
4 Graduate assistants currently on appointment are exempt from music fees in the major field if the student is a music major.

HOUSING

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

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

UNIVERSITY DINING SERVICE

The University offers a variety of dining services operated in the Student Union and in the Garden Court Restaurant at the Park Student Center. The range includes specialty snack bars, cafeterias, and a complete table-service restaurant. Campus vending locations are also offered. All Aboard is the university meal plan that is available to all students. For additional information, write: All Aboard, S.U.P.O. 10,000, Tucson, AZ 85720. Approximate monthly food cost for the average student is $240.00.

STUDENT SERVICES

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 Adviser; the American Indian Student Adviser; and the Veterans' office. For full information concerning each of these, the student should consult the Dean of Students Office or the General Catalog.
GENERAL REGULATIONS

The Nature of Graduate Work

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

Admission

Admission to the Graduate College is open to qualified applicants who hold the bachelor's degree from the University of Arizona or from a college or university which grants degrees recognized by the University of Arizona. 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 non-credit courses, workshops, and seminars offered by other postsecondary institutions as part of continuing education programs.

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

GRADE-POINT AVERAGE

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

GRADUATE RECORD EXAMINATION (GRE)

Normally applicants must submit scores on the Graduate Record Examination in order to complete the admission process. Scores on the aptitude test of the Graduate Record Examination are used to supplement other evidence of preparation for graduate work. Such scores are only one component of the credentials used to make admission decisions, and they are evaluated in the context of the complete record in the application folder of each applicant. No formal minimum scores on standardized examinations are required for admission to the Graduate College. A number of departments, however, have specific requirements with regard to the Graduate Record Examination, the Graduate Management Admissions Test, or other examinations. Some may require applicants to take the advanced GRE in the appropriate discipline. Academic departments and departmental headnotes in the Departments and Courses of Instruction section of this catalog should be consulted for further information. It is important that the examination be taken as early as possible in the academic year. Applications for the examinations, which are administered locally as well as in other centers, should be sent, together with the examination fee, to Graduate Record Examinations, Educational Testing Service; Box 6000; Princeton, New Jersey 08541-6000.

REGULAR GRADUATE STATUS

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

ADMISSION WITH DEFICIENCIES

An additional number of undergraduate courses may be required when previous work has not approximated the general requirements for the corresponding bachelor's degree at the University of Arizona or the special requirements for the field in which the candidate proposes to specialize. With departmental approval, a limited number of course deficiencies may be satisfied after admission to a graduate program; however, this work will not receive graduate credit.

PROVISIONAL ADMISSION

Provisional admission indicates some reservation on the part of the Graduate College with regard to the applicant's qualifications to undertake graduate work leading to an advanced degree. This restriction does not, however, impair the student's opportunity to earn graduate credit in properly selected courses. If admitted provisionally, a student who then completes nine credit hours of graduate work with superior grades will be in good standing, subject to any additional requirements established by the major department or academic unit. Students admitted provisionally because they lack only GRE scores may request conversion to regular graduate status immediately upon the receipt of the scores in the Graduate College and may have the requirement to complete nine credit hours of graduate work waived. Students on provisional status who wish to be admitted to regular graduate status should obtain the "Provisional to Regular Graduate Status Request Form" from the Graduate College and follow the directions on the form. Only a student in Regular Graduate Status can be awarded a degree.

ADMISSION FOR A PART OF EACH ACADEMIC YEAR

Some individuals may be admitted to a degree program with the understanding that they will enroll for only one semester or summer session during each academic year. These students must be identified in writing by the Department and their Graduate College files so noted. These students must maintain the usual academic standards and are required to attend a minimum of one semester or summer session per year. Upon meeting the minimum standards, the students would not be required to apply for readmission. The Department can revoke this status at any time if, in their judgment, the student is not making reasonable progress.

GRADUATE NONDEGREE STATUS

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

ADMISSION OF INTERNATIONAL STUDENTS

Nonimmigrants should request graduate application forms from the Graduate Student Admissions Office and departmental requirements and materials from the major department. Effective fall semester 1991, all international student applications, with required credentials, must reach the Graduate Student Admissions Office before February 1 for the summer and fall terms and August 1 for the spring term. International applications may apply for a deferment of their application processing fee until enrollment if they are from Hungary, Liberia, Poland, Tunisia, the U.S.S.R. or Zimbabwe. All other international applicants must submit a $25.00 processing fee with their application. Faxed documents for international applicants will be accepted for department review purposes only. An official document must be submitted before formal admission to the Graduate College will be granted. Some graduates of foreign institutions may be admitted initially as International Special Students for a period of enrollment limited to two academic terms with the understanding that they may be required to undertake some work without graduate credit in order to make up deficiencies in preparation. In any event, no commitment can be made regarding the time required to complete a course of study.

INTERNATIONAL SPECIAL STATUS

Students admitted to this status are full-time students, taking a minimum of nine hours of credit per semester. Those units may be in appropriate courses at either the undergraduate or graduate level. At the conclusion of the student's first semester in residence, the Graduate College and the academic unit to which the student seeks admission will evaluate the student's progress. If the academic unit recommends a change to Regular Graduate Status, the student can receive graduate credit for
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. New applicants should request that one set of complete official transcripts/degree certificates of all undergraduate and graduate work be sent to the University of Arizona directly by the institution where the work was completed. All applications and supporting documents should be sent to the Graduate Admissions Office, University of Arizona, Administration Building, Room 322, Tucson, Arizona 85721-0001. Credits which appear as transfer credits on any other transcript are not valid; applicants must submit an official transcript from the school where the credits were earned. Applications and required credentials for domestic applicants must be submitted to the Graduate Admissions Office before August 1 for fall term and December 1 for spring term. 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.

FINANCIAL RESOURCES FOR INTERNATIONAL 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 evidenced 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.

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 Application for Candidacy, with appropriate signatures, to the Graduate College. Students in doctoral programs submit the Doctoral Application for Candidacy. Upon approval of the appropriate form by the Dean of the Graduate College, the student is admitted to candidacy.

Graduate Credit

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 adviser. 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

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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.

REPEATING COURSES

Please see "Course Listing Information" under Departments and Courses of Instruction elsewhere in this catalog.

USE OF 400-LEVEL COURSES IN GRADUATE PROGRAMS

A graduate student may, with the approval of his or her major and minor advisors and department heads, use up to six units of 400-level course work 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 satisfactory completion of such additional courses as may be prescribed by the head of the corresponding department in the University.

In any case, transfer of credit toward an advanced degree will not be made unless approved by the head of the major department, unless the grade earned was A or B, and unless it was awarded graduate credit at the institution where the work was completed. Furthermore, transfer will be made of credit only; no account will be taken of the grades of transfer work in computing the student's grade point average. Such transfer, which must be arranged by the student through the Graduate Degree Certification Office, may be initiated at any time but will not become effective until the student has completed satisfactorily at least twelve units of graduate work at the University of Arizona.

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

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

CORRESPONDENCE COURSES

Correspondence courses will not be accepted for graduate credit.

Grading System

The grading system used by the University of Arizona follows:

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

EXAMINATIONS REQUIRED

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

WITHDRAWAL GRADES

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

SPECIAL GRADES

The grades S (superior) or P (passing) are used in place of grades A or B respectively for individual studies courses numbered 591, 593, 594, 599, 691, 693, 694, 699, 791, 793, 794, 795, 900, 908, 909, 910, 915, 920, and 925. The only grades available in courses numbered 599, 699, and 799 are S, P, C, D, E, I, and W. For courses numbered 595, 596, 695, 696, 795 and 796, the instructor may use these special grades or the regular letter grades as departmental policy or the instructor's own policy dictates; but all registrants in a given instance are graded by the same system. Grades available for 900 are S, P, C, D, E, K, and W. The only grades available for 908, 909, 910, 915, 920, and 925 are S, P, E, K, and W. The only grade available for 930 is K. Special grades (S, P) are not used in the computation of the grade point average.
AVERRAING 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 University of Arizona course work for which the student has enrolled for graduate credit, whether or not it is offered in satisfaction of requirements for an advanced degree, except for courses in which grades of P or S have been awarded. To meet condition (b), the grade-point average is computed in a like manner but only on courses included in an approved graduate study program 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.

Enrollment Policies

FULL-TIME STUDENT STATUS

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

MAXIMUM ENROLLMENT

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

MINIMUM ENROLLMENT

Each student admitted to a graduate degree program who, during any academic term, is associated with the University in any capacity that makes use of University facilities or faculty time must register. During the fall and spring semesters, a minimum of three units of graduate credit will be required; during any summer 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 must still register may 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 are included in the student's unit load and the fees are the same as a registration for credit. For the purpose of reporting full- or part-time student status to outside agencies, however, only those courses taken for credit are counted. After the fourth week of classes, a change from credit to audit will be permitted only if the student is doing passing work in that course, and receives the approval of the course instructor and the Dean of the Graduate College.

Graduate Study in Summer Sessions

Graduate study is available during the University of Arizona summer sessions. All courses numbered at the 500, 600, 700, or 900 levels are graduate courses. 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 IN SUMMER SESSION

Tuition per unit of credit for the 1991-92 academic year is $80.00. 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 and an Arizona Financial Aid Trust fee of $3.00. Since fees are subject to change, students should consult the current Summer Session Schedule of Classes for fees in effect for any given year.

Graduate Appointments, Scholarships and Financial Aids

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

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

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 $2,763 to $5,319 for services not exceeding ten hours a week, or $5,527 to $10,652 for half-time assistantships.

Tuition and Fees

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

Academic Requirement

Graduate assistants and associates must maintain a University of Arizona graduate grade point average of 3.00 or better.

Minimum Enrollment

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

Maximum Enrollment

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

Additional Information

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

SCHOLARSHIPS, FELLOWSHIPS, TRAINEESHIPS, GRANTS, AWARDS

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

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

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

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

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

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

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

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

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

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

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

A separate application is required for the Guaranteed Student Loan Program. An applicant must be admitted to a degree program before submitting the application to the Office of Student Financial Aid. The total processing time at the University, bank and guaranty agency can take up to four months. Therefore, early application is advised.
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
aerospace engineering
agricultural & biosystems engineering
agricultural economics
agricultural education
agronomy & plant genetics
American Indian studies
anatomy*
animal sciences
anthropology
applied mathematics
architecture
art
art education
art history
astronomy
atmospheric sciences
bilingual/bicultural education
bilingual/multicultural education
biochemistry
biology (general)
biophysics
botany
business administration
cancer biology
chemical engineering
chemistry
civil engineering
classics
communication
comparative literature & literary theory
composition (music)
computer science
counseling & guidance
creative writing
dairy science
dietetics
East Asian studies
ecology & evolutionary biology
Economics
educational media
educational psychology
electrical engineering
elementary education
engineering mechanics
English
English as a second language
epidemiology
exercise and sport sciences
family and consumer resources
finance
food science
foundations of education
French
geology
geographical engineering
geosciences
German
health education
higher education
history
home economics education
horticulture
hydrology
industrial engineering
journalism
landscape architecture
language, reading & culture
Latin American studies
library science
linguistics
management and policy
management information systems
marketing
materials science & engineering
mathematics
mechanical engineering
media arts
mechanical & industrial engineering
mechanical & aerospace engineering
mechanical &生物 systems engineering
medicine
microbiology & immunology
mineral economics
mining engineering
molecular & cellular biology
music education
musicology
Near Eastern studies
neuroscience
nuclear engineering
nutrition
nutritional sciences
optical sciences
performance (music)
pharmaceutical sciences
pharmacology
pharmacy
philosophy
physics
physiological sciences*
planetary sciences
planning
plant pathology
political science
poultry science
psychology
public administration
range management
reading
reliability engineering
renewable natural resources studies
Russian
secondary education
sociology
soil & water science
Spanish
special education
special education & rehabilitation
speech & hearing sciences
statistics
systems engineering
teaching & teacher education
theatre arts
toxicology
water resources administration
watershed management
wildlife & fisheries science

*Applicants are not admitted directly to this degree program. The degree is awarded only in rare instances when individuals admitted to Ph.D. programs are forced to terminate early.
**Major Fields for Specialist Degrees**

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

- educational administration
- educational media
- educational psychology
- nursing
- language, reading and culture
- special education & rehabilitation

**Major Fields for Doctoral Degrees**

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

- aerospace engineering
- agricultural & biosystems engineering
- agronomy & plant genetics
- anatomy
- animal sciences
- anthropology
- applied mathematics
- arid lands resource sciences
- astronomy
- atmospheric sciences
- biochemistry
- biology (general)
- biophysics
- botany
- cancer biology
- chemical engineering
- chemistry
- civil engineering
- communication
- comparative literature & literary theory
- composition (music/A.Mus.D.)
- computer science
- conducting (music/A.Mus.D.)
- counseling & guidance**
- East Asian studies
- ecology & evolutionary biology
- economics
- educational administration
- educational psychology
- electrical engineering
- engineering mechanics
- English
- entomology
- epidemiology
- family and consumer resources
- foundations of education
- French
- genetics
- geography
- geological engineering
- geosciences
- higher education
- history
- horticulture
- hydrology
- language, reading and culture*
- linguistics
- management
- materials science & engineering
- mathematics
- mechanical engineering
- microbiology & immunology
- mineral economics
- mining engineering
- molecular & cellular biology
- music education (A.Mus.D.)
- music theory
- Near Eastern studies
- neuroscience
- nuclear engineering
- nursing
- nutritional sciences
- optical sciences
- performance (music/A.Mus.D.)
- pharmaceutical sciences
- pharmacology and toxicology
- pharmacy
- philosophy
- physics
- physiological sciences
- planetary sciences
- plant pathology
- political science
- psychology
- range management
- renewable natural resources studies
- rhetoric, composition & the teaching of English

*Both Ph.D. and Ed.D. degrees are offered.
**At the time of catalog editing, the Doctor of Education and Doctor of Philosophy were under review. Consult the Graduate College for further information.

**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 Business Administration (M.B.A.)
- Master of Business Administration (M.B.A.)
- Master of Fine Arts (M.F.A.)
- 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.)
- 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 APPLICATION FOR CANDIDACY
Consult the Graduate College for deadline dates by which the Master's Application for Candidacy must be submitted to the Graduate College. This notice, approved by the major advisor and the department head on forms provided by the Graduate College, shall set forth the student's program of study and other information required by the Graduate College. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the 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 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.

FINAL EXAMINATION
A candidate for the master's degree must pass a final examination, oral or written or both, administered by a committee of at least three faculty members (including at least two from the major department) recommended by the major department for appointment by the Dean of the Graduate College. The result of the examination must be reported to the Graduate College no
later than three weeks before the end of the semester. Any candidate who fails the final examination may, upon recommendation of the major department and approval of the Graduate Council, be granted a second examination after a lapse of at least one semester. The second examination is final. The report of successful completion of all requirements must be made to the Graduate College at least 21 days before the date on which degrees are awarded.

THESIS

A thesis is required in many master's programs. The appropriate departmental statement in this catalog will indicate thesis requirements for each degree. Where a thesis forms part of the program, a limited number of units may be earned for its preparation. 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 special 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 desired 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.

PUBLICATION OF THESIS

Master's theses are published by University Microfilms, Ann Arbor, Michigan. Upon certification by the student's major professor, members of the committee for the final examination, and the Graduate College, a thesis copy and an abstract of 150 words or less are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for processing with the thesis and must be carefully prepared for microfilming according to specifications set forth in the Thesis Manual.) The manuscript is cataloged and microfilmed and the negative inspected and put in vault storage; the catalog information is sent to the Library of Congress for printing and distribution of cards for depository catalogs and libraries. The abstract is printed in Microfilm Abstracts and distributed to leading libraries in the United States and abroad, and to a selected list of journals and abstracting services. The copy is then returned to the University of Arizona Library. Publication by microfilm does not preclude publication by other methods later, and successful candidates are urged to submit thesis material for publication in a scholarly or professional journal. Suitable acknowledgment must always indicate the publication to be a thesis, or portion of a thesis, submitted in partial fulfillment of the requirements for a master's degree at the University of Arizona.

SECOND MASTER'S DEGREE

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

Master of Arts and Master of Science

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

Master of Accounting

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

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

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

The required courses consist of a 15-hour core: Acct. 510, 526, 528, 531, and 569. The balance of the 30 hours is to be completed with electives. Each candidate must pass a written comprehensive examination.

Master of Agricultural Education and Master of Home Economics Education

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

Master of Architecture

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

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

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

Master of Business Administration

The M.B.A. degree program is designed to prepare women and men for leadership and administrative positions in a wide variety of organizations. It is intended for liberal arts, engineering, science and other nonbusiness majors, as well as for business majors. Previous business courses are not required. Undergraduate courses in finite mathematics 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.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):

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, entrepreneurship, financial markets and investment analysis, financial institutions, 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/multicultural education, educational administration, educational media, educational psychology, elementary education, foundations of education, higher education, reading, secondary education, and special education.

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

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

Master of Fine Arts

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

MAJOR IN ART

Applicants must submit slides of their studio work (or in the case of the photography program applicants, original photographs) directly to the Department of Art. All other application materials, including transcripts, are to be sent to the Graduate College. No application will be considered until slides or photographs, transcripts, and application forms have been received. The requirements are the same as those for the degree of Master of Arts with the following exceptions. The unit requirement for this program is sixty units, of which twelve must be in art history, art criticism, or related areas, 30 in studio area of concentration, and 15 in related electives (as approved by major advisor). In lieu of a thesis, an original work, or group of such works, must be presented to the public. Review of this work will accompany the final oral examination. The exhibit may be accompanied by a written document, but the document itself will not be considered a thesis. As evidence of completion of this work, a folio of slides or photographs of the exhibition must be submitted to the Art Department graduate committee upon completion of the final examination. The candidate may be required to prepare a one-person exhibit of the work or to participate in a group exhibit during the last semester in residence.

MAJOR IN CREATIVE WRITING

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

MAJOR IN THEATRE ARTS

The unit requirement for this program is sixty units. Concentrations are available in acting-directing, in design-technical production, or in dramatic writing. Applicants for the acting-directing option must submit a resume and at least three letters of recommendation and must arrange for an audition and interview. Applicants for design-technical production must submit renderings and slides or photographs of theatrical design or technical work directly to the department. Applicants for dramatic writing must submit at least two samples of original dramatic writing and letters of recommendation from at least three persons 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, 605, 606, 650, 655, 656, 693, 4 units of 696b, 909, 6 additional units of theatre history, dramatic theory, or criticism, 3 units of T.Ar. 691, and one unit of Mus. 699. In lieu of a thesis, each student must present a monograph on the performance of an acting recital prepared and presented according to departmental guidelines. (b) Directing Emphasis. Program requirements are

Master of Landscape Architecture

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

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

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

Master of Library Science

The Graduate Library School offers a program leading to the Master of Library Science degree. See also the headnotes under Library Science elsewhere in this catalog. The program is fully accredited by the American Library Association.

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

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

The program requires completion of a minimum of 36 units of graduate credit. No thesis is required. A more detailed description of the program is available from the Graduate Library School.

**Master of Music**

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

**MAJOR IN PERFORMANCE**

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

**MAJOR IN COMPOSITION**

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

**MAJOR IN MUSICOLGY**

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 the master's degree program in music education must qualify for teacher certification prior to completion of the degree. The program requires a minimum of 30 graduate units, with no more than six units of credit in special workshops. The degree culminates in a major project which demonstrates individual accomplishment of a creative, pedagogical, musical, or scholarly nature.

**MAJOR IN MUSIC THEORY**

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

**Master of Public Administration**

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

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

- 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 or 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, criminal justice, financial management, social policy, and natural resource policy. Students with excellent first year records may design individual specializations if warranted.

Finally, a 6-unit internship is required.

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

**Master of 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 College of Education or the Division of Teaching and Teacher Education for information regarding the status and requirements of all programs and degrees.
REQUIREMENTS FOR SPECIALIST DEGREES

Educational Specialist

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

ADMISSION

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

QUALIFYING EXAMINATION

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

TIME LIMITATIONS

Requirements for the Educational Specialist degree shall be completed within a period of six calendar years after satisfactory completion of the qualifying examination. Students who are able to demonstrate to the satisfaction of the qualifying examination committee that they have kept abreast of current developments in their areas of study may have prior course work 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 adviser. The duties of the committee are: (1) to evaluate the student's proposed program of study, (2) to make recommendations regarding the program to the Dean of the Graduate College through the appropriate division head, and (3) to be available to the student for advice as needed.

PROGRAM OF STUDY

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

FINAL EXAMINATION

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

Except for school psychology, candidates are required to furnish evidence of a minimum of two years of successful teaching or administrative experience as approved by the 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 adviser after consideration of previous academic work and experience, personal interests, and professional objectives. Two options are available: (1) An applicant with a bachelor's degree in nursing may enroll for the combined M.S. and N.S. degree programs by declaring the intent to prepare in a subspecialty area. A minimum of 60 units must be completed, including 36 from the courses required for the clinical concentration leading to the M.S. degree plus an additional 24 units of course work. This option generally requires two semesters beyond the time required for completion of the master's degree (see the headnotes under Nursing elsewhere in this catalog). The thesis will be directed toward some aspect of nursing care in the selected subspecialty area. (2) An applicant who has completed the master's degree in nursing at an institution accredited by the National League for Nursing may receive the Nursing Specialist degree by completing a minimum of 28 units.

QUALIFYING EXAMINATION

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

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

A research paper and a final comprehensive examination are required for the Nursing Specialist degree.
REQUIREMENTS FOR DOCTOR'S DEGREES

Doctor of Philosophy

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

RESIDENCE AND CREDIT REQUIREMENTS

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

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

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

The dissertation requires the equivalent of at least two semesters of full-time work. Registration for a minimum of eighteen units of dissertation credit (920) is required during the conduct of the dissertation. With the prior approval of the student's 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, including work done for the master's degree (if applicable), cannot exceed a period of ten years.

MAJOR AND MINOR SUBJECTS

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

QUALIFYING EXAMINATION

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

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

PRELIMINARY EXAMINATION
Before admission to candidacy for the degree, the student must pass a general examination in the chosen fields of study. This examination is intended to test the student's general fundamental knowledge of the fields of the major and minor subjects of study. It shall include written portions covering the major and minor fields and, 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 committee approval form 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 submit the Doctoral Application for Candidacy to the Graduate College. Upon acceptance of this form by the Graduate College, the student will be recommended to the Graduate Council for acceptance as a candidate for the doctorate. 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, an announcement of the examination is filed with the Graduate College. 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 for the College of Education files and one for the dissertation director. In other colleges, the major department, at its option, may require an additional copy for the departmental files. A manual of instructions relating to the form of the dissertation may be obtained from the Associated Students' Bookstore.

PUBLICATION OF DISSERTATION
Ph.D. dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee of $25 is charged to cover this expense. Upon certification by the student's major professor, members of the committee for the final examination, and the Graduate College, a dissertation copy and an abstract of 350 words or less are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for inclusion in the dissertation and must be carefully prepared for microfilming according to specifications set forth in the Dissertation Manual.) The manuscript is cataloged and microfilmed and the negative inspected and put in vault storage; the catalog information is sent to the Library of Congress for printing and distribution of cards for depository catalogs and libraries. The abstract is printed in Microfilm Abstracts and distributed to leading libraries in the United States and abroad, and to a selected list of journals and abstracting services. The copy is then returned to the University of Arizona Library.

Publication by microfilm does not preclude publication by other 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 therefrom related to the field of study. The exact time and place of this examination shall be made available to the Graduate College at least three weeks in advance and announced publicly at least one week in advance. The examination shall be open to the public. The committee shall be appointed by the Dean of the Graduate College in consultation with the major and minor departments.

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

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

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

RESIDENCE AND CREDIT REQUIREMENTS

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

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

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

The dissertation requires the equivalent of at least two semesters of full-time work. Registration for a minimum of eighteen units of dissertation credit (920) is required during the conduct of the dissertation. With 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 Education, including work done for the master's degree (if applicable), cannot exceed a period of ten years.

MAJOR AND MINOR SUBJECTS

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

QUALIFYING EXAMINATION

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

PROGRAM OF STUDY

A proposed program of study recommended by the department or departments concerned must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the 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.)

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 academic units. No later than three weeks prior to the proposed date of the examination, the request for approval of the examination committee 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 announcement of the examination is filed with the Graduate College. 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 academic unit 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 for the College of Education files and one for the dissertation director. A manual of instructions relating to the form of the dissertation may be obtained from the Associated Students’ Bookstore.

PUBLICATION OF DISSERTATION

Dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee is charged to cover this expense. Upon certification by the student’s major professor, members of the committee for the final examination, and the Graduate College, a copy and an abstract of no more than 350 words are forwarded to University Microfilms. (This abstract is in addition to the two abstracts required for inclusion in the dissertation and must be carefully prepared for microfilming according to specifications set forth in the Dissertation Manual.) The manuscript is microfilmed and the negative inspected and put in vault storage. The manuscript is cataloged and the catalog information sent to the Library of Congress for printing and distribution of cards to depository catalogs and libraries. The abstract is included in the forthcoming issue of Microfilm Abstracts, which is distributed to leading libraries here and abroad, and to a selected list of journals and abstracting services. The first copy is then returned to the University of Arizona Library. Publication by microfilm does not preclude publication by other methods 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 announced to 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 this catalog.

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

RESIDENCE AND CREDIT REQUIREMENTS

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

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

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

At the beginning of the first semester in residence, diagnostic examinations in music history and music theory must be taken if not already completed.

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

MAJOR AND MINOR SUBJECTS

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

QUALIFYING EXAMINATION

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

**ADVISORY COMMITTEE**

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

**PROGRAM OF STUDY**

A proposed program of study recommended by the School of Music and any other department concerned must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the 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 paragraphs on the specific requirements for the majors in composition, conducting and performance at the end of this section.)

**PRELIMINARY EXAMINATION**

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

**ADVANCEMENT TO CANDIDACY**

After satisfying any written and oral portions of the preliminary examination and giving evidence of ability to carry on professional studies at the highest level, the student will submit the Doctoral Application for Candidacy to the Graduate College. Upon acceptance of this form by the Graduate College, the student will be recommended to the Graduate Council for acceptance as a candidate for the degree of Doctor of Musical Arts. These requirements must be met no later than three months prior to the final oral examination.

**FINAL EXAMINATION**

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

**SPECIFIC REQUIREMENTS FOR THE MAJOR IN COMPOSITION**

Approval of a major in composition will be based upon evidence of creative talent and a knowledge of craftsmanship in writing music. In lieu of a dissertation, the candidate will compose a major work of approximately thirty minutes duration. Registration for a minimum of eighteen units of dissertation credit (920) is required during the preparation of the composition. Following the examination the candidate submits to the Graduate College a final copy (approved and accepted by the School of Music and all members of the examining committee) together with approval pages and special abstract. The abstract addresses the formal, stylistic, and technical 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 performances with major university ensembles. Conductors work in a secondary conducting area for the second recital. The candidate submits to the Graduate College for review a final copy of the completed lecture document (approved and accepted by the School of Music and all members of the examining committee). After making any required corrections, the candidate submits two complete and signed unbound copies of the document to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier.

**SPECIFIC REQUIREMENTS FOR THE MAJOR IN PERFORMANCE**

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

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

The candidate will prepare and submit a formal document in connection with the lecture-recital. This document, based on some aspect of performance or performance practice, must show evidence of the candidate’s ability to select and organize data pertinent to the study. The document should be an original contribution to the field of knowledge in the candidate’s chosen subject area, and should demonstrate the candidate’s ability to communicate effectively in writing. Following a successful final oral examination, the candidate will submit one bound copy of the Lecture Recital Document to the University Music Library for placement in its permanent collection. The candidate submits to the Graduate College for review a final copy of the completed lecture document (approved and accepted by the School of Music and all members of the examining committee). After making any required corrections, the candidate submits two complete and signed unbound copies of the document to the Graduate College for delivery to the University Library. A processing fee must be paid to the University Cashier.
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, 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.] I 1991-92 Critical review of modern theory and research on social structure and social organization in modern societies. 2R, 3L. P, 6 units of sociology or CR. (Identical with Hist. 506) Smith

Explanation:

506.—Course number.
Social Structure in Modern Societies—Course title.
(3)—Number of units.
[Rpt].—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.] indicates that the course may be repeated for credit once, for a total of two enrollments. [Rpt./2] indicates that the course may be repeated for credit twice, for a maximum of three enrollments in the course; [Rpt./6 units] means that the course may be repeated until the student has received a total of 6 units of credit. It is the student's responsibility to ensure that course content is not duplicated.
I—Semester in which course is usually offered. I indicates fall semester; II, spring; S, summer. To ascertain course offerings for a particular semester, consult the Schedule of Classes.
1991-92—Year in which course is offered. If no year designation is given, the course is offered each year.
Critical review...societies.—Course description.
2R, 3L—Class structure. R, L, S, and D indicate “recitation,” “laboratory,” “studio,” and “discussion.” In the sample above, 2R, 3L indicates that the class meets two hours of recitation and three hours of laboratory per week (based upon 15 weeks). For courses consisting of recitation (lecture) periods only, the number of class hours per week is the same as the unit value and is not specified in the course description.
P—Prerequisites. Identifies courses or other experiences which must be completed prior to enrolling in the course listed.
CR—Concurrent registration. Identifies courses which must be taken during the same term as the course listed. (Identical with Hist. 506)—Crosslisting. Identifies other departments which give credit for the same course. The complete course listing is shown in the course list of the “home” department, which has instructional responsibility for the course. An abbreviated listing appears in the course list of the “crosslisting” department. Exceptions are house-numbered courses, which do not have course descriptions.
Smith—Professor in charge.
Note: Not all of the above information may be noted in any individual course.

UNIVERSITY-WIDE “HOUSE-NUMBERED” COURSES

Most University of Arizona courses use a combination of lectures, discussions and laboratories as their basic teaching for-
594, 694, 794. Practicum (Credit varies) The practical application, on an individual basis, of previously studied theory and the collection of data for future theoretical interpretation.
Grades Available: S/P, C, D, E, I, W.

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

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

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

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

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

915. Master's Recitals (Credit varies) For master's students in performance.
Grades Available: S/P, E, K, W.

920. Dissertation (Credit varies) 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 graduate students in music performance.
Grades Available: S/P, E, K, W.

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

*Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
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 Andrew D. Bailey, Jr., Head, William B. Barrett, Dan S. Dhaliwal, William L. Felix, Jr., William S. Waller
Associate Professor Jane F. Mutchler
Assistant Professors Sanjay Kallapur, Sharon S. Lasser, Jeffrey W. Schatzberg, Galen R. Sevcik, Brian P. Shapiro, E. Kay Stice, Mark A. Trombley, Shing-wu Wang

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

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

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

*May be convened with 400-level course.

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

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

527. Tax Aspects of Real Estate Transactions (3) II Gains and losses on sales and exchanges of property for tax purposes; capital and ordinary gains and losses, realization, transfer by gift or at death, use in trade or business, installment sales, and depreciation recapture provisions. P. 401, 422.

528. Taxation of Partnerships (3) II 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) II A professional course for those who expect to pursue public accounting as a career. P. 431.

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

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

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

556. Tax Factors in Business Decisions (3) I II Introduction to the federal taxation of income for all types of taxpayers and to the taxation of transfers of wealth, with emphasis on the effect of taxes on business decisions. Open only to students admitted to BPA graduate degree programs. Not open to accounting majors. Credit allowed for this course or 326, but not for both. P. 210 or 551.

559. Information and Financial Decision Support for Investment Planning (3) I II 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)

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


696. Seminar 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); 106 I II

797. Workshop a. Research Design (1) [Rpt./6 units] I II Open only to Ph.D. students in accounting.

Aerospace and Mechanical Engineering (AME)

AME Building, Room 301
(602) 621-2235


Associate Professor Abhijit Chandra, Kee-Ying Fung, An Glezer, Edward J. Kerschen, Seth H. Lichter
Assistant Professors Ara Arabyan, ChoLik Chan, Jeffrey W. Jacobs, Erdogan Madenci, Alfonso Ortega, K.R. Sridhar

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in aerospace engineering or in mechanical engineering. Students in either major may select one of the following interdisciplinary options: biomedical engineering, energy systems engineering, materials engineering, or reliability engineering. For information concerning these options see Engineering elsewhere in this catalog.

A Bachelor of Science degree from an aerospace or a mechanical engineering curriculum of a recognized institution of higher education is required of applicants to the graduate program. In general, a grade average of "B" or better in previous academic work is expected. Graduates from other engineering, mathematic, and physical sciences curricula may be admitted provisionally. All applicants must submit scores from the Graduate Record Examination general test and Engineering subject test.

Majors

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

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

Degrees

Master of Science: All students are required to complete 31 units of graduate work, including 24 at the 500 level and 1 unit of 696. A student
may elect to present a Master's thesis (up to six units) or a Master's report (up to three units). All students are required to complete 532a-532b. (Students in the reliability engineering option may take 574 and Stat. 566 or S.I.E. 530 as a substitute.) Normally, no more than three units of independent study or sponsored-projects courses may be taken for degree credit. All students are expected to attend the weekly graduate seminar. A final oral examination is required.

Doctor of Philosophy: Students should take the Qualifying Examination during their first semester of residence. After completing all or nearly all the required course work, the Preliminary Examination may be scheduled. A written examination on the major subject is given after the student has passed the written examination on the minor subject. Minor subjects may be chosen from other engineering, physical sciences, or mathematics departments. All students are expected to attend the weekly Aerospace and Mechanical Engineering Seminars.


502. Modeling and System identification in Dynamic Engineering Systems (3) I 1991-92 Principles of mathematical modeling of engineering problems; state and parameter identification techniques; lumped and distributed system; open loop (explicit) and closed loop (implicit) applications; frequency and time domain representation; deterministic and stochastic inputs. P, 302; CR, 455.


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


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


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


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


534. Radiative Heat Transfer (3) I 1991-92 Fundamentals of radiative heat transfer; radiative properties of materials; gray-body and spectral exchange between surfaces; participating media; radiation combined with conduction and convection. Intended for students with strong interests in heat transfer, combustion, and applications such as energy conversion systems, materials processing, and space technology. P, 432.

536a-536b. Fundamentals of Fluid Mechanics (3-3) 536a: Fundamental equations of motions; surface tension; kinematics of vorticity; integral solutions; irrotational flows; simple viscous flows. P, 331b; CR, 500a, 536b: Small-disturbance inviscid theory; low Reynolds number flow; vorticity dynamics; boundary layers. P, CR, 500b.

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

538. Nature of Turbulent Shear Flow (3) I 1992-93 Physical phenomena in turbulent shear flows; experimental techniques; observations and physical consequences; prediction methods; recent advances. P, 500b, 536a-536b.


542. HVAC System Design (3) II (Identical with N.E.E. 542)

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


552. Advanced Computer-Aided Analysis of Mechanical Systems (3) II Computer-aided methods in multibody dynamics; Euler parameters; automatic generation and numerical methods in solving equations of motion; application in vehicle dynamics, spacecraft, and robotics. P, knowledge of kinematics, dynamics and numerical methods.


555. Modern Control Theory (3) II 1992-93 Controllability and stability for linear and nonlinear systems, observer design, qualitative methods of optimal control and game theory applied to control system design. P, 455.


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

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

563. 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, 461.

566.* Biomechanical Engineering (3) II One subject covered yearly from: biomechanical solid mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation exercise, hyperthermia, instrumentation). P, 302, 330, 331b.
Agricultural and Biosystems Engineering (ABE/ABT)

Shantz Building, Room 507
(602) 621-1607


Associate Professors M.D. Cannon (Emeritus), Wayne E. Coates, William G. Geisler, Dennis L. Larson, William O. Rasmussen, Muluneh Yitayew

Assistant Professor Gregory J. Fleischman
Assistant Research Scientist Robert L. Roth
Associate Extension Specialist Thomas Scherer

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

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

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

A thesis is normally required, but the requirement may be waived for a student who is the senior author of a manuscript published or accepted for publication in a refereed professional journal.

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

Agricultural and Biosystems Engineering (ABE)


II 1992-93 Application of systems analysis to agricultural and biologically related systems problems; computer modeling and use of operations research methods. P. Stat. 361. Larson

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


555. Irrigation Engineering (3) II Introduction to soil and water relationships, irrigation systems, irrigation water supply, and irrigation management; basic designs. P. C.E. 321. (Identical with C.E. 555)


557. Irrigation Engineering Laboratory (2) I Methods of data acquisition 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. CR. 455.

558. Drainage of Irrigated Lands (3) II Origin and nature of drainage problems in arid lands; drainage theories, investigations and design for irrigated agriculture. Field trip. P. C.E. 321 or A.M.E. 331a. (Identical with C.E. 558)


563. Energy from Biomass (3) II Biomass energy resources; collection and processing methods; thermal, anaerobic digestion and fermentation conversion processes, energetic, economic and environmental issues. P. A.M.E. 240. (Identical with N.E.E. 563) Larson

605. Soil-Water Dynamics (3) II 1992-93 (Identical with S.W. 605)

650. Advanced Irrigation Management (3) II 1991-92 Irrigation scheduling using Jensen-Haise and Penman equations for predicting evapotranspiration; determination of crop coefficients; production functions, economics, and


696. Seminar
a. Agricultural and Biosystems Engineering (1) Rpt. I II Yitayew

Agricultural and Biosystems Technology (ABT)


506.* Applied Hydraulics (3) I Fundamentals of hydraulics applicable to the irrigation of agricultural lands, including fluid properties, hydrostatics, irrigation flow characteristics, open channel and pipeline applications, and measurement of flowing water. P. Math. 118, 123 or 125A, Phys. 102A. Yitayew

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

551. Water Management for Small Scale Agriculture (3) S Evaluation, design, construction and maintenance of water harvesting, runoff farming and other small scale water management systems. Intended for professionals from developing countries. Daily field work. Field trips.

556.* Food Engineering (3) II 1992-93 Fundamentals of fluid flow, materials handling, heat transfer, refrigeration, freezing and drying as applied to food processing. (Identical with N.F.S. 565) *May be convened with 400-level course.

Agricultural Biochemistry and Nutrition

(See Nutritional Sciences)

Agricultural Economics (aec)

Economics Building, Room 208 (602) 621-6241

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

Associate Professors Bonnie B. Colby, Roger A. Dahlgren, Eric A. Monke, James C. Wade, Paul N. Wilson

Assistant Professor Gary D. Thompson

Visiting Associate Professor Neilson C. Conklin

Adjunct Professor Harry W. Ayer

Research Scientist Edwin H. Carpenter

Assistant Research Scientist Mark W. Langworthy

Extension Specialist Russell L. Gum

Extension Economist Russell E. Transtad

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 in economics with emphases in agricultural or natural resource economics.

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

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

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

512. International Agricultural Economic Development (3) I The role of agriculture in economic growth and development, including economic policies related to agriculture, and trade in agricultural commodities. (Identical with Econ. 510) Fox/Monke

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

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

516.* 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. P. Econ. 201b or Geog. 305. (Identical with Geog. 516)


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. 539a. Kuehl

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

544. In the Wake of the Green Revolution (3) [Rpt I] II (Identical with Anth. 544)

546.* Consumer Economics (3) I II (Identical with C.S. 546)

549. Applied Econometric Analysis (3) II (Identical with Econ. 549) Dahlgran

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) II Review and analysis of economic growth and development in Latin America with emphasis on the agricultural sector. P. Econ. 201a-201b. (Identical with Econ. 559 and L.A.S. 559) Fox/Finan

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

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

575.* Economics of Land and Water in the American West (3) I Economic analysis of natural resource issues, policies and management alternatives. Case studies will focus on public and tribal lands, river basins, wildlife, mineral and forest resources in the western U.S. P. 217 or 476 or Econ. 201a. (Identical with Econ. 575 and R.N.R. 579) Colby

*May be convened with 400-level course.


577. Natural Resource Economics and Public Policy (3) II Advanced economic theory and evaluation of land and water resource issues and public policies for graduate students in natural resource-related disciplines. Topics include water quality, water allocation, public lands management, and valuation of non-market resources. P. Econ. 361 or 476. (Identical with Econ. 577, H.W.R. 577, and W.N. 577) Colby
Agricultural Education (AED)
Forbes Building, Room 222A
(602) 621-1523

Professors Roger T. Huber, Acting Head, Gordon J. Graham (Emeritus), Clinton O. Jacobs (Emeritus), Floyd G. McCormick (Emeritus), Kenneth S. Olson, Phillip R. Zurbrick
Associate Professor David E. Cox
Assistant Professor Glen M. Miller

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

Degrees

Master of Science: The program requires the completion of at least twenty units in agriculture and agricultural education. Supporting work shall be in business administration, education, psychology, sociology or in other approved disciplines appropriate to teaching, extension, and similar educational work. Thirty units, including a thesis (for which a maximum of six units may be earned) must be completed.

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

538. Extension Education (3) I 1991-92 Philosophy, principles and methodology in the development, implementation and evaluation of extension education programs (identical with H.E.E. 538)

539.* Non-Formal Education (3) II Characteristics and scope of non-formal education. Principles and application of non-formal education methods to diffuse knowledge in adult and continuing education setting. (identical with H.E.E. 539)

*May be convened with 400-level course.

540. International Agricultural Extension Education (3) I 1992-93 Critical evaluation of case histories of international extension education models, and integration of successful components into composite models based on cultural, political and educational situations typically encountered in developing countries.

597. Workshop
a. Occupational Experience Program (1-3) [Rpt./3] I 1
b. Youth Leadership Development (1-3) [Rpt./3] I I
c. Extension Credibility and Accountability (1-2) [Rpt./2] (identical with H.E.E. 597c)
d. Administration, Management, and Supervision of Cooperative Extension (1-3) [Rpt./2] (identical with H.E.E. 597d)
e. Continuing Education in Agriculture (1-3) [Rpt./3] I I
f. Program Planning and Evaluation (1-3) [Rpt./3] I I
g. Microcomputers-Extension (1-2) [Rpt./2] (identical with H.E.E. 597g)
i. Video Communications and Methods (1-2) [Rpt./2] (identical with H.E.E. 597i)

Agricultural Education (AGRI)
Forbes Building, Room 201
(602) 621-3612

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

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

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

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

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

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

Family and Consumer Resources
nutrition .................................. M.S.
dietetics .................................. M.S.

Nutritional Sciences
food science .................................. M.S.
nutritional sciences .......................... M.S./Ph.D.

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

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

Renewable Natural Resources
landscape architecture ................................ M.L.Arch.

Plant Sciences
range management ................................ M.S./Ph.D.

dairy science .................................. M.S./Ph.D.
watershed management .......................... M.S./Ph.D.

Soil and Water Science
soil and water science .......................... M.S./Ph.D.

Veterinary Science .......................... No graduate majors except in cooperation with certain other departments.

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

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

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

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), Lawrence J. Evers (English), Jerrold Levy (Anthropology), N. Scott Momaday (English), J. Jefferson Reid (Anthropology), Joseph Stauss (Family and Consumer Resources), Susan W. Steeie (Linguistics), Robert K. Thomas, Robert Williams, Jr. (Law)

Associate Professors Thomas M. Holm (Political Science), Alice S. Paul (Elementary Education)

Assistant Professors Jennie Joe (Family and Community Medicine), 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 vita, published articles or other materials relevant to admission.

Master of Arts (major in American Indian studies): 30 units, plus a six-unit thesis. The course work consists of 15 units of core courses, including 502a-502b, 584a-584b, and three units to be determined by the Committee. In addition, the student must complete 15 units in a field of concentration chosen from art, language, anthropology, literature, education, business or any other related area approved by the Committee. The student should work closely with three faculty 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 private organizational work, to teach at the college and university level, and to work in a variety of public agencies in the area of civil rights and social programs. A concentration in American Indian studies provides students with a thorough background in the political history of the American Indian and the federal government and provides the tools and analytical skills necessary to understand the past and present situation of the American Indian, thus preparing the student for policy-making, tribal planning or other government positions. For information concerning this concentration, also see the Department of Political Science.

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

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

516. Contemporary Indian America (3) II (Identical with Anth. 516)

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

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

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

549a-549b. Folklore (3-3) (Identical with Eng. 549a-549b)

567. Race and Ethnic Relations (3) I II (Identical with Soc. 567)

577. American Indian Literature (3) (Identical with Eng. 577)

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)

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


596. Seminar a. American Indian Law and Policy (3) [Rpt. 2] I II (Identical with Pol. 596h, which is home.)

m. Studies in the Oral Tradition (3) [Rpt. 9 units] I II (Identical with Eng. 596m, which is home)

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

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

Professors Robert S. McCuskey, Head, Jay B. Angevine, Jr., Joseph T. Bagnara, William D. Barber, David E. Blask, Bryant Benson, Robert W. Gore (Physiology), Mac E. Hadley, Mary I. Johnson (Pediatrics), Philip H. Kutzsch (Emeritus), Donald P. Speer (Surgery), Nicholas J. Strausfeld (Arizona Research Laboratories, Neurobiology)

Associate Professors Mary J. C. Hendrix, C. Ward Kischer, R. Clark Lantz, Christopher A. Leadem, Albert V. LeBouton, Mary E. Morbeck (Anthropology)

Assistant Professors Gail D. Burd (Molecular and Cellular Biology), Nathaniel Mullen, Mary Rykowski, Paul A. St. John, Jean M. Wilson (Pediatrics)

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

The undergraduate major need not be in the biological or chemical sciences, but the applicant must have completed at least one year of general science and at least 15 units in the biological sciences. It is advisable that the applicant present at least one course in comparative anatomy, genetics, or general physiology. A limited number of deficiencies may be satisfied after admission. Applicants must submit scores on the aptitude test and one advanced test (biology preferred) of the Graduate Record Examination and four letters of recommendation from former science instructors familiar with their academic ability and personal character.

Degrees

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

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

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


515. Reproductive Biology (3) I Structure, function and control of the mammalian reproductive system with emphasis on human reproduction.

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

555. Cancer Biology (3) II 1990-91 (Identical with Micr. 555)

556. Developmental Biology (3) I (Identical with M.C.B. 556)

557. Experiments in Developmental Biology (4) II (Identical with M.C.B. 557)

558. Advanced Subjects in Endocrinology (2) [Rpt. I Selected topics in vertebrate and
invertebrate endocrinology. P. 457R. (Identical with M.C.B. 558)

567R.* Endocrinology (3) II Neural and endocrine integration in the regulation of mammalian physiological functions. P. M.C.B. 103. (Identical with M.C.B. 567R)

567L.* Endocrinology Laboratory (1) II Techniques in endocrinology. P. CR, 567R. (Identical with M.C.B. 567L)

571.* Human Embryology (4) II Normal and abnormal development of the human with functional aspects stressed. Includes maturation of germ cells to fertilization to birth. Lecture, discussion and demonstration format. P. M.C.B. 181, 182, Ecol. 153a-153b, 160a-160b or M.C.B. 456 or 457, or consult with department. (Identical with Ecol. 571 and M.C.B. 571)

577. Principles of Cell Biology (4) II Intensive, graduate-level introduction to principles and mechanisms of cell biology, including current research strategies in the field. P, consult department before enrolling. (Identical with M.C.B. 577)

582. Topics in Neural Development (2) II 1989-90 (Identical with Nhrs. 582)

583. Topics in Neural Plasticity (2) I 1990-91 (Identical with M.C.B. 583)

584. Cellular Neurobiology (II) II 1989-90 Focuses on a different selected topic in the cell biology of neurons and glial cells each offering. Students read and critically discuss primary literature. P, course in neurobiology or cell biology, consult with department before enrolling. (Identical with M.C.B. 584 and Nhrs. 584)

588. Principles of Cellular and Molecular Neurobiology (II) I 1989 (Identical with Nhrs. 588)

589. Principles of Systems Neurobiology (4) II (Identical with Nhrs. 589)

595. Colloquium d. Special Topics in Cell Biology (2) (Rpt/6 units) I (Identical with C.Bio. 595d)

*Introduction to the Neurosciences (2) 1991-92 (Identical with Med. 595y, which is home)

*May be convened with 400-level course.

601. Human Gross Anatomy (8) I Comprehensive survey and gross structure of the human body. P. Chem. 103b, 104b, 243b, 245b; Phys. 102b, M.C.B. 181, 182; consult department before enrolling.

602. Microscopic Anatomy (5) I Essentials of microscopic human anatomy. P. Chem. 103b, 104b, 243b, 245b; Phys. 102b; consult department before enrolling.

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

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

605a-605b. Human Neuroscience (3-3) 605a: Morphological organization of the human central nervous system. P. Chem. 103b, 243b, 245b, Phys. 102b, M.C.B. 410a-410b. Consult department before enrolling. 605b: Neurotransmitters and intrinsic regulatory functions. Consult department before enrolling. (Identical with Phcl. 605a-605b and Psio. 605a-605b)


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

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


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

802. Microscopic Anatomy (3) II Morphological anatomy of the human central nervous system and neurotransmitters and intrinsic regulatory functions. (Identical with Neu. 805a-805b, Phcl. 805a-805b, and Psio. 805a-805b)

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**Animal Sciences (ANS)**

Shantz Building, Room 205 (602) 621-7623


The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in animal sciences. Areas of study include nutrition of beef and dairy cattle, reproduction and breeding, muscle growth and function, animal stress, and meat science. Departmental faculty also participate in interdepartmental graduate committees on Genetics, Nutritional Sciences, and Physiological Sciences in offering the Ph.D. degree.

Applicants are expected to submit a detailed statement of professional goals and two letters of recommendation from instructors who are in a position to predict the applicant's potential as a graduate student.

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**Animal Growth and Development (2) II 1992-93** 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 Biol. 460 or 462a.

**513. Quantitative Genetics (3) I 1992-93** Theory of quantitative genetics including idealized populations, forces that change gene frequency, breeding systems, and estimation of genetic parameters in a population. P. 6 units of genetics. (Identical with Gene. 513)

543. Research Animal Methods (3) I (Identical with V.Sc. 543) May be convened with 443.

549. Diseases of Wildlife (3) II (Identical with V.Sc. 549) May be convened with 449.

*May be convened with 400-level course.


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


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

615. Chemistry and Metabolism of Lipids (3) I II 1991-92 (Identical with N.F.S. 615)

622. Mineral Metabolism (2) I 1991-92 (Identical with N.F.S. 622)

635. Ruminant Nutrition (3) I Recent findings in ruminant nutrition; the physiochemical processes of digestion and absorption; importance and metabolism of rumin microflora; normal metabolism and abnormal metabolic disorders; modes of action of feed stimulants. P 430, 435; Chem. 241a, 243a.


665. Chemistry of Food Proteins (3) II 1992-93 The chemical and physical properties of proteins important to their use as food; analysis and purification of proteins; biochemical properties of proteins in muscle, milk, eggs, cereals, and other foods. P, Bioc. 462a preferred, Bioc. 460 acceptable. (Identical with Bioc. 665 and N.F.S. 665) Go!


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

Anthropology (ANTH)
Anthropology Building, Room 210 (602) 620-2585


Associate Professors Constance Cronin, Mary Ellen Morbeck, Mark Nichter, John W. Olsen, Richard A. Thompson, Stephen L. Zegura

Assistant Professors Daniel Nugent, Thomas K. Park, Willem deReuse

The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees. The major consists of courses and eighteen units of supporting work. Students must register in the field of cultural anthropology. Specific course requirements for the Master of Arts degree are as follows: 18 units of advanced courses and a written thesis. The Doctor of Philosophy requires 50 units of advanced courses and an oral defense of an original study. The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees. A Master of Arts degree requires the completion of 36 units of coursework plus the dissertation. The minor, consisting of fifteen or more units, may be taken within the department. Special requirements include reading knowledge of a foreign language and a working knowledge of modern statistical methods.

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

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

501. Ancient Mesopotamia (3) I Sumerian, Babylonian, and Assyrian civilization from the first cuneiform documents to the fall of the neo-Babylonian empire, with special attention to issues of sociopolitical organization. P, N.E.S. 51, N.E.S. 101, 110 or consult department before enrolling. (Identical with Hist. 501 and N.E.S. 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 violence 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 to urban areas, focusing on different group or region each semester.

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

507. 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.

509. Economic Anthropology (3) I Analysis of production, exchange, distribution, consumption, property, economic surplus, inheritance, and types of economic structure. P. 200, or 12 units of economics. (identical with Econ. 509 and L.A.S. 509)

510. Ceramic Ethnoarchaeology (3) II 1992-93 Using ethnoarchaeological and ethnographic case studies from different geographical areas, the course examines relationships
between ceramics and a range of matters traditionally of interest to archaeologists.

511. Anthropology of Religion (3) I Comparative approaches to the study of religion; systems of ritual and symbolization in the primitive world; shamanism and 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; P. 200.

514. Late Quaternary Geology (3) (Identical with Geos. 514)

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

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

517. Cultures 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. (Identical with L.A.S. 517)

518a-518b. Scientific Illustration-Photography (2 to 4—2 to 4) (Identical with Ecol. 518a-518b)

519. Psychological Anthropology (3) II Cultural emphasis and experiences as basic shaping forces in personal development and emotion. Topics include psychoanalysis and anthropology, gender and sexuality, childhood, grief and mourning, dreaming, psychopathology. P. 102, 200 or other cultural anthropology course.

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


522a-522b. Pre-Columbian Art (3-3) (Identical with Ar.H. 522a-522b)

523. Peoples of Mexico (3) II Cultural background and contemporary economic, social, and religious life of the Indian and mestizo populations of Mexico. (Identical with A.In.S. 523 and L.A.S. 523)

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

527a. The Prehistory of East Asia (3) I The origins and subsequent development of prehistoric cultures in China, Japan, Korea, Mongolia, Siberia and Southeast Asia. Broad concepts such as cultural change and environmental adaptation are stressed in order to draw parallels among these geographically and culturally diverse regions. P. 101. (Identical with E.A.S. 527a)

527b. The Archaeology of Pre-Han China (3) II The origin and florescence of Chinese culture and civilization from an archaeological perspective. An in-depth survey of Chinese prehistory and early history from the early Pleistocene to the third century BC. 527a is not a prerequisite for 527b. P. 101; consult department before enrolling. (Identical with Chn. 527b)


529. Cultures and Societies of Africa (3) II Ethnology and social anthropology of African peoples including their ecology, social organization, and systems of thought. P. 3 units of anthropology.

530. The Anthropology of Visual Art (3) II An introduction to the anthropology of visual art and the interdisciplinary methodologies and techniques of studying art and aesthetics cross-culturally as sociocultural phenomena. P. 200. (Identical with A.In.S. 530)

531. Anthropology and Development (3) II The role of anthropology in interdisciplinary projects involving economic development and planned change on the national and international levels. P. 3 units of anthropology. (Identical with L.A.S. 531)

532. Peoples of the Pacific (3) I Populations and cultures of Polynesia, Micronesia, and Melanesia; variability of these "natural laboratory" settings in an ecological framework.

533. Laboratory in Zooarchaeology (3) II Fragmentary animal remains are investigated in archaeological interpretation. Diagnostic morphological features; role in cultural interpretation. Analytical techniques; lab. analysis; report preparation. 1R, 6L.

534. Kinship and Social Organization (3) II Principles in the comparative study of social systems; types of social structure. P. 200, or 9 units of anthropology. (Identical with Soc. 534)

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

536a-536b. Medical Anthropology (3-3) I 11 Medical Anthropology of illness and health. Lay perceptions of health, ethnophysiology and pathology; pluralistic ideas about illness experiences; indigenous ideas about preventative and promotive health; folk dietetics; social labeling; and illness responsibility attribution. Emphasis on the study of health culture and how the subjective experience of illness and health is influenced by cultural variables. Draws upon cross-cultural ethnographic research and consideration of American health culture. 536a: Comparative medical systems and healing traditions, regional health arenas, and health care seeking. Topics include folk medicine, traditional medical systems, distinctive illness and public health problems, patterns of resort in the use of pluralistic medical resources, and the way in which the practice of biomedicine has been adapted to regional culture. Explores the medical cultures of Mexico and Latin America, Native America, Africa and Asia. 536a is not prerequisite to 536b.

537a-537b. Readings in Akkadian (3-3) Readings in selected literary, religious and economic texts designed not only to improve language mastery but to use those documents in elucidation of specific topics in Mesopotamian culture. P. 484a-484b. (Identical with N.E.S. 537a-537b)

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


540a-540b. Cross-Cultural Communication (3-3) 540a: Linguistic Fieldwork. 540b: Cultural Fieldwork. 540a is not a prerequisite to 540b.

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

542. Museum Collections Management (3) I Principles and procedures governing the acquisition, documentation, care and use of museum collections. 2R, 3L.

543a-543b. The Archaeology of Neolithic and Bronze Age Greece (3-3) (Identical with Cls. 543a-543b)

544. In the Wake of the Green Revolution (3) [Rpt.] I Survey of agricultural and fisheries production, marketing, and research activities in Sonora, Mexico, locus of "Green Revolution" in wheat breeding. Field trip conducted during Spring Break. P. consult department before enrolling. (Identical with A.Ec. 544)

545. Museum Exhibition (3) II Method and theory in museum exhibit design.

546. Museum Conservation (3) II An introduction to the examination of the nature and properties of materials in anthropological collections and their deterioration, restoration, and preservation.

548. Writing Culture (3) [Rpt.] I The development of anthropological writing as it has moved toward cultural critique: the use of knowledge of other cultures to examine the assumptions of our own. Comparison of ethnographic examples.

549a-549b. Folklore (3-3) (Identical with Engl. 549a-549b)

551. Archaeology of North America (3) I In-depth survey of the development of culture in North America from the time of the initial peopling of the New World to the historic period.

552R. Archaeology of the Southwest (3) I Development of culture in the prehistoric Southwest from the late Pleistocene to the historic period.

552L. Archaeology of the Southwest (3) II The nature of archaeological data recovered in the Southwest, with emphasis on their potential for the drawing of both cultural and chronological inferences.

553a-553b. Mesoamerican Archaeology (3-3) I Development of culture in Mexico and Central America from the origins of agriculture through the Spanish Conquest. 553a: Maya culture. 553b: The culture of Mexico north of the Maya area. 553a is not prerequisite to 553b. (Identical with L.A.S. 553a-553b)

555a-555b. *Old World Prehistory (3-3)* I A survey and interpretation of archaeological evidence for human cultural development of the Old World prior to the appearance of literate societies. 555a: The Paleolithic; from earliest tools to the cave artists at the end of the Ice Age. 555b: From hunting and gathering to megalithic monuments following the Ice Age.

556. *Prehistoric Mesopotamia (3)* I Theories of the rise of civilization tested against archaeological data from Mesopotamia with comparative material from other areas. Time period: end of the Paleolithic to historic Sumerian civilization. (Identical with N.E.S. 557)

558. *Historical Archaeology* (3) II 1991-92 Survey of the basic data and methods of research in the material culture of modern history. The New World from first European contacts to the 20th century.

559. *Agricultural Economic Development in Latin America* (3) II (Identical with A.Ec. 559)

560. *Paleoindian Origins* (3) I Chronological development of Paleo-Indian occupation of the New World in relation to environmental changes of the Quaternary Period; site discoveries, case studies, hypothesis on the peopling of the Americas. Field trip. (Identical with Geos. 561)

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

563. *Evolution of Ancient States and Civilizations* (3) II 1992-93 Classical and modern theories used to explain the rise of ancient states and civilizations are evaluated as systems of anthropological logic and for their ability to elucidate the archaeological record. Major topics include the nature of growth trajectories, variability in ancient states, the collapse of states, and constraints of growth in selected areas of the world. P, consult department before enrolling.

564a-564b. *Introduction to Dendrochronology* (3-3) (Identical with Geos. 564a-564b)

565. *Women in International Development* (3) II The impact of international development on women as agricultural producers, householders, migrants, workers in formal/informal labor markets and participants in planned change. (Identical with F.C.R. 565 and L.A.S. 565)


567. *Race and Ethnic Relations* (3) I (Identical with Soc. 567)

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

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

571a-571b. *Applied Medical Anthropology in Western Contexts* (3-3) 1992-93 Investigations of the illness experience; symbolic interpretations of medicines and medical procedures; doctor-patient communications and illness narratives. 571a demonstrates the applicability of major social science theories in the related study of health-related behavior. 571b focuses on methods of data collection and presents case studies illustrating the application of methods in the study of designated health problem areas, interviewer transference and issues of reflexivity. P, 536a.


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

574. *Ethnobotany* (3) II Survey, with emphasis on cultural uses of plants, both past and present; discussions of contributions to the theory and techniques of the emergence of agricultural ethnobotany, ethnomedicine, and other aspects of ethnobotany. P, 8 units of biology or anthropology.


578. *Archaeological Analysis with Geographic Information Systems* (3) II 1991-92 An overview of computer concepts, techniques, and algorithms fundamental to Geographic Information Systems (GIS). Emphasis is placed on the use of GIS to examine, analyze, and model archaeological and environmental distributions within areas of study.

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

580. *Historical Comparative Linguistics* (3) I Types and mechanisms of linguistic change; language and dialect formation; determination of prehistoric connections; reconstruction of proto-languages and cultures, and their origins in time and space. P, 276.


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

586. *Comparative Community Development* (3) I (Identical with Soc. 586)

587. *Poverty and Health* (3) II (Identical with N.E.S. 584a-584b)

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

589. *Women in Middle Eastern Society* (3) I Middle Eastern society viewed from the perspective of women. Examines the extent to which formal definitions of women's nature and roles coincide with women's self-images and activities. (Identical with N.E.S. 490)

590. *Bilingual Health Communication* (3) I (Identical with Nurs. 595e)


b. The Dynamics of Human Subsistence (3) I 1991-92 Consult department before enrolling.

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

* Experimental Archaeology (3) I

* Bilingual Clinical Analysis (3) I

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

q. Near Eastern Archaeology (3) [Rpt.] I II (Identical with N.E.S. 596f, which is home)

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

*May be convened with 400-level course.

597. *Workshop* A. Physical and Forensic Anthropology I (2) [Rpt.] I Consult dept. before enrolling.

b. Physical and Forensic Anthropology II (2) [Rpt.] I Consult dept. before enrolling.
600. Survey of Cultural Anthropology (3) I
Intensive introduction, overview, and synthesis of cultural anthropology.

635. Foundations of Archaeology (3) II
A comprehensive introduction to archaeology, including a survey of major problems in the cultural record and the methods and concepts employed in archaeological research and interpretation.

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

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

645. Early Civilizations (3) [Rpt./2] II
Comparative analysis of early civilizations from both the Old World and the New World, with emphasis on regularities in cultural development. P. 454, 456, 457.

665. Survey of Physical Anthropology (3) II
Modern physical anthropology including evolutionary theory, genetics, skeletal biology, primatology, paleoanthropology, human growth, adaptability and demography.

666. Human Microevolution (3) II [Rpt.]

675a-675b. Anthropology and International Health (3-3) 1992-93 An intensive overview of the field of international health and anthropologists' contributions to it. Responses to biotechnology, primary health care and child survival, diseases and development; health care utilization patterns; world systems and multinational pharmaceutical industry; health care bureaucracies; interaction between traditional medicine and public health. 675b: Health transitions and the household production of health with emphasis on anthropological investigations of health within a broader development context. P. 536a.

679. Language and Ethnography (3) I

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

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

696. Seminar
a. Archaeology (1-3) [Rpt./3] II
b. Cultural Anthropology (1-3) [Rpt./3] II (Identical with N.E.S. 696b)
c. Linguistic Anthropology (1-3) [Rpt./3] II

Applied Mathematics (APPL)
Mathematics Building, Room 414
(602) 621-4664

Committee on Applied Mathematics (Graduate)
Professors W. David Arnett (Physics), Thomas F. Balsa (Aerospace and Mechanical Engineering), Bruce R. Barrett (Physics), Harrison H. Barrett (Radiology), Peter Carruthers (Physics), James M. Cushing (Mathematics), William Dallas (Radiology), Chandana Desai (Civil Engineering), Donald G. Dudley (Electrical and Computer Engineering), William Fars (Mathematics), Hermann Fasel (Aerospace and Mechanical Engineering), Hermann Flaschka (Mathematics), Robert L. Gall (Atmospheric Sciences), Barry D. Ganapole (Nuclear and Energy Engineering), W. Martin Green (Mathematics), Joseph F. Gross (Chemical Engineering), Robert L. Hamblin (Sociology), Juan C. Heinrich (Aerospace and Mechanical Engineering), David L. Hetrick (Nuclear and Energy Engineering), William B. Hubbard (Lunar and Planetary Sciences), Bobby R. Hunt (Electrical and Computer Engineering), J. Randolph Kojikii (Astronomy, Planetary Sciences), John O. Kessler (Physics), Stephen Koch (Physics), George L. Lamb, Jr. (Mathematics, Optical Sciences), Willis E. Lamb, Jr. (Optical Sciences, Physics), Averill M. Law (Management Information Systems), Robert Griffith (Lunar and Planetary Sciences), David O. Lomen (Mathematics), H. Jay Melosh (Lunar and Planetary Laboratory), Pierre Meyste (Optical Sciences Center), Richard E. Michod (Ecology and Evolutionary Biology), Richard L. Morse, Donald E. Myers (Mathematics), Shiome Neuman (Hydrology), Marcel F. Neuts (Systems and Industrial Engineering), Alan C. Newell (Mathematics), Arizona Research Laboratories, Charles M. Newman (Mathematics), Adrian N. Patrasciouci (Physics), Robert Roemer (Aerospace and Mechanical Engineering), Michael L. Rosenzweig (Ecology and Evolutionary Biology), Hannu Rund (Mathematics), William M. Schaffer (Ecology and Evolutionary Biology), Alwyn C. Scott (Mathematics), Moshe Shaked (Mathematics), Vernon L. Smith (Economics), Malur K. Sundareshan (Electrical and Computer Engineering), Terry Triffet (Engineering Mechanics), Thomas L. Waples (Aerospace and Mechanical Engineering), James R. Wait (Electrical and Computer Engineering), Arthur W. Warrick (Soil and Water Science), Arthur T. Wintere (Ecology and Evolutionary Biology)

Associate Professors Timothy W. Seoborn, Acting Chairperson (Psychology, Arizona Research Laboratories), Donald G. Askin (Systems and Industrial Engineering), Adam S. Burrows (Physics), Francois E. Cellier (Electrical and Computer Engineering), Abhijit Chandra (Aerospace and Mechanical Engineering), Peter J. Downey (Computer Science), Nicholas M. Ercolani (Mathematics), William Filippone (Nuclear and Energy Engineering), K. Y. Fung (Aerospace and Mechanical Engineering), Thomas Kennedy (Mathematics), Edward J. Kerschen (Aerospace and Mechanical Engineering), C. David Levermore (Mathematics), Udi Manber (Computer Science), S. Mazumder (Physics), Eugene W. Myers, Jr. (Computer Science), Ramesh Narayan (Steward Observatory), Simon A. White (Steward Observatory), Maciej Wojtkowski (Mathematics), Arthur L. Wright (Mathematics), Lai-Sang Young (Mathematics)

Assistant Professors Bruce J. Bayly (Mathematics), Moyse, Brey (Mathematics), Cho Lik Chan (Aerospace and Mechanical Engineering), Knise, Wing Chow (Mathematics), Jeffrey B. Goldberg (Aerospace and Industrial Engineering), Brendan LeMesurier (Mathematics), Jonathan I. Lunine (Planetary Science), Erdogan Madenci (Aerospace and Mechanical Engineering), William C. Tittemore (Planetary Science), J. Bruce Wash (Ecology and Evolutionary Biology)

The Committee on Applied Mathematics offers courses of study leading to the Master of Science and Doctor of Philosophy degrees with a major in applied mathematics. It supports and encourages research in the many areas of physical, biological, social and engineering sciences in which mathematics and modeling play intrinsic roles.

Students entering the programs are expected to have a strong background in mathematics including advanced calculus and basic probability theory. However, entry to the programs is not restricted to students who have had mathematics as their undergraduate major. Courses of study in the major programs are flexible and individually designed. In the first year, most students are strongly recommended to take a sequence of core courses offered by the Department of Mathematics, which includes numerical analysis, principles of analysis, and methods of applied mathematics. In addition, students in their first year attend a series of weekly case studies in which members of the committee describe recent or current research work involving applications of mathematics.

For the Doctor of Philosophy degree, a dissertation is required. This dissertation should contain original contributions by the student to the solution of a mathematical problem in a scientific discipline, or to the development of mathematical methods for classes of such problems.

Members of the committee are currently involved in a wide range of research activities with applied mathematical components. The departmental affiliations of the faculty listed above give an indication of the breadth of activities. For detailed information about areas of
research, admission requirements and courses of study, please contact the Committee on Applied Mathematics.

Arabic
(See Near Eastern Studies)

Architecture (ARCH)
Architecture Building, Room 104
(602) 621-6751


Associate Professors Harry der Boghossian, Dennis Doxtater, Robert W. Dworak, Charles M. Poster
Assistant Professors Richard Ebeltolf, Abigail Van Slyck

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


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

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

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

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

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

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

522.* Urban Design (3) I II Study of design communication in urban settings including perception, way finding and systems of signage. Class project of a specific urban area required. P, 222, 301.

524.* Modern Architecture (3) I II Study of recent architectural developments throughout the world, focusing on the personalities, theories and issues influencing built form since 1945. P, 334.

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

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

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

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


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

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

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

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

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

577.* Architecture and Human Process (3) Social science-based theoretical continuum of built environment as human information. Begins with individual responses from environmental psychology. defines social uses of places, and addresses culturally expressive meanings in environment. Projects analyzing actual settings provide the link to design applications. P, 302.

580.* Computer Applications in Architecture (3) I Advanced self selected projects exploring potential applications in computer-aided design with emphasis on graphic modeling. Seminars on technical topics with intensive use of graphic work stations. P, 470.

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

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

596. Seminar
a. * Readings in Architecture (2-4) [Rpt] I II Open to majors only.

597. Workshop
a. Architecture (3-8) [Rpt] I II Open to majors only. (Identical with Ping. 597a)
b. * Special Projects in Architecture (1-3) [Rpt/6 units] I II S Consent college before enrolling.

Arid Lands Resource Sciences (ARL)
845 N. Park Avenue, Room 102
(602) 621-1955

Committee on Arid Lands Resource Sciences (Graduate)

Professors Paul G. Bartels (Plant Sciences), Robert B. Bechtel (Psychology), Michael E. Bonine (Geography/Near Eastern Studies), Herbert E. Carter (Biochemistry, Emeritus), Dennis C. Cory (Agricultural Economics), Stanley Davis (Hydrology), Peter F. Foltiott (Renewable Natural Resources), Martin M. Fogel (Renewable Natural Resources), Kenneth E. Foster, Roger Fox (Agricultural
Art (ART/ARH/ARE)

Art Building, Room 104
(602) 621-7570

Professors Moira M. Geoffrion, Head, Warren H. Anderson (Emeritus), Robert Cololecott, Michael F. Croft, Douglas Denniston (Emeritus), Margaret B. Doogan, Judith Golden, Dwayne Greer, Maurice K. Grossman (Emeritus), Harmony Hammond, Carl R. Heldt, Charles V. Hitter, Donald J. Irving, Luis Jimenez, Dennis Jones, Vincent Lanier (Emeritus), Charles Little (Emeritus), Bruce E. McGrew, Robert W. McMillian (Emeritus), Ellwood C. Parry, Ill, Robert M. Quinn (Emeritus), Sheldon Reich, Barbara Rogers, Jean Rush (Emerita), Lynn Schroeder (Emeritus)

Associate Professors Rosemarie T. Bernardi, Jerold Bishop, Jackson Boelet, James G. Davis, John F. Herli, Harold J. Jones, D. Keith McElroy, Bart J. Morse, Andrew Polk, Kenneth Shorr, Robert P. Tobias, Gayle E. Wimmer

Assistant Professors Jeanne M. Carrigan, Au- rore M. Chabot, Lynne Bialbrait, Sheila Pitt, Alfred Quiroz, Joyan Saunders, Stacie G. Widdfield, Jane Welch Williams, Jeryldene Wood

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

Admission to advanced degree programs requires appropriate undergraduate preparation at this institution, or one of similar standing, not more than ten years prior to the date of entry.

Programs

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

Master of Arts (major in art history): Applicants may be admitted with 18 units of graduate 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 30-unit requirement. A maximum of 9 units may be in individual studies including 900 and 910. A reading knowledge of French or German or other approved language must be demonstrated before the Comprehensive Examination may be taken and the Comprehensive Examination be passed prior to undertaking thesis work. The Comprehensive Examination may be taken no more than twice. A thesis is required.

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

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

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

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

Special facilities for graduate work include the works devoted to art within the T. E. Hanley Collection of 37,000 volumes; the Samuel H. Kress Collection of 14th to 19th Century European art, including the surviving panels of the Retablo of Ciudad Rodrigo by Fernando Gallego; the Charles Leonard Pfeiffer Collection of American art, consisting of more than 100 contemporary American paintings; the Edward Joseph Gallagher III Memorial Collection of contemporary American paintings and European, Latin American, and Oriental objects of art; and miscellaneous collections, including the University Print Collection of notable examples of various graphic arts. The Center for Creative Photography houses 50,000 photographic prints, archives of negatives, correspondence and memorabilia as well as a specialized library. Over 21,000 volumes.

For further information concerning this degree see Requirements for Master's Degrees/Master of Fine Arts elsewhere in this catalog.

505. Graduate Figure Drawing (3) [Rpt./5] II Special problems in drawing, using the classroom model and outside sources as references for personal expression. 6S.

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


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

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 courses.

548.* Video for Artists (3) [Rpt./1] II Seniors 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) II Relief printmaking with emphasis on individual research, personal direction and professional standards. 6S. Fee.

551. Graduate Intaglio (3) II Intaglio printmaking with emphasis on individual research, personal direction and professional standards. 6S. Fee.

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

555. Graduate Lithography (3) II Lithography with emphasis on individual research, personal aesthetic, and professional standards. 6S. Fee.
565. Graduate Graphic Design Problems (3)  
[Rpt./1] I II Two- and three-dimensional design considerations with emphasis on conceptualization and presentation. 6S. Field trips. Fee. P. acceptance of portfolio.

566. Editorial Illustration (3)  
[Rpt./1] I Problems in editorial and book illustration. 6S. Fee. P. 9 units of illustration courses and approval of portfolio.

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

568. Portfolio Preparation (3)  
[Rpt./1] II Final approach to completion of portfolio. Student's portfolio is critiqued in areas of order, style, and degree of presentation to bring it to a professional level. 6S. Fee. P. 9 units of graphic design courses and approval of portfolio.

571. Advanced Jewelry and Metalsmithing I (3)  
[Rpt./4] I A study of the various materials and methods in the construction of jewelry and metalwork. 6S. P. 9 units of metalwork.

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

573. Advanced Ceramics (3)  
[Rpt./5] I Individual studio research and instruction, with emphasis on personal creative development. 1R. 4S. Fee. P. 373, acceptance of portfolio by ceramic faculty.

576. Advanced Fibers (3)  
[Rpt./5] I Individual interpretations of concept into finished fiber works. P. 276; 9 units of intermediate fibers.

578. Graduate Two-Dimensional Fiber Techniques (3)  
I Advanced fiber technique course for graduate students who wish to develop further their strengths in special technical areas. Stresses two-dimensional work. 6S. P. consult department before enrolling.

579. Graduate Three-Dimensional Fiber Technique (3)  
I Advanced fiber technique course for graduate students who wish to develop further their strengths in special technical areas. Stresses three-dimensional work. 6S. P. consult department before enrolling.

580. Graduate Painting (3)  
[Rpt./5] I II Graduate study in painting with an emphasis on the development of a personal imagery and body of work. 6S.

582. Projects in Recent Art (3)  
[Rpt./6 units] II 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, constructions, image sequences, and elements from other art forms (sound, language, movement, etc.).

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

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

596. Seminar  
p. Photography and Language (3)  
[Rpt./1] II 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. Painting Concepts (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 highly concentrated student and faculty discussion.

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

655. Graduate Printmaking (3)  
[Rpt./18 units] I II Printmaking with emphasis on aesthetics, conceptualization, technical competency, artistic, literary, and personal direction. 6S. Fee. P. consult department before enrolling.

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

673. Graduate Studio in Ceramics (6-10)  
[Rpt./6] I II I S Studio research and instruction with emphasis on personal creative development. 12 to 20S. Field trips. Fee. 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 20S. P. 476.

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

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

Art History (ARH)

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

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

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

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

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

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

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

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

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

525.* Northern Baroque Painting (3)  
I II Painting in Belgium and the Netherlands during the 17th century. P. 119.

528.* 17th- and 18th-Century Art in Italy (3)  
Painting, sculpture, and architecture of the Baroque and subsequent periods. P. 6 units of history or art history.

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

554.* Greek and Roman Sculpture (3)  
(Identical with Clas. 554)

556.* Greek and Roman Painting (3)  
(Identical with Clas. 556)

557.* Greek Architecture (3)  
(Identical with Clas. 557)

581.* Contemporary Theory and Criticism (3)  
I II Discussion of the theory and criticism of contemporary art since 1960 based on assigned readings and slide presentations. Field trips.

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

596. Seminar  
a. American Art (3)  
[Rpt./2] I II  b. Problems in Renaissance-Baroque (3)  
[Rpt./2] I II  c. Studies in Medieval Art (3)  
[Rpt./2] I II  d. Pre-Columbian Art (3)  
[Rpt./4] I I P. consult instructor before enrolling. (Identical with Anth. 596e)

f. History of Photography (3)  
[Rpt./4] II P. 424a or 424b.
Art Education (ARE)

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

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


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


596. Seminar
h.* Current issues in Art Education Theory and Practice (3) [Rpt./12 units] I II

*A may be convened with 400-level course.

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

633. Issues and Recent Research in Art Education (3) I The identification of problems in art education at various curricular levels; examination of related research with possible implications for practice.

693. Internship
a. Art Therapy (1-3) [Rpt./15 units] I II Open to majors only. 3-9 L. P, 532; consult department before enrolling.

Astronomy (ASTR)

949 N. Cherry Avenue, Room 203 (602) 621-2288

Professors Peter A. Strittmatter, Head, J. Roger Angel, William David Arnett, John Black, Thomas Gehrels (Lunar and Planetary Laboratory), William F. Hoffman, J. R. Jokipii, James W. Liebert, Frank J. Low, George H. Rieke, Elizabeth Roemer, Thomas L. Swiftart, Roger P. Hutchings, Tiffon, Simon White (Physics), Neville J. Wolff

Associate Professors Adam Burrows, Williams J. Cocke, Craig Hogan, Robert C. Kennicutt, Jr., Charles J. Lada, Ramesh Narayan, Andrzei G. Pacholczyk, Marcia Rieke, Gary D. Schmidt, Raymond E. White, Erick T. Young

Assistants Professors Jill Bechtold, Christopher Impey

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

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

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

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

Successful completion of the introductory course sequence, consisting of 502, 515, 522, 540 or 575, 535, 585 for alternate years, as well as 3 graduate physics courses, constitutes demonstration of qualification for more advanced graduate work in either the Master of Science or the Doctor of Philosophy program.

Doctoral students from other departments who elect to minor in astronomy must complete 12 acceptable graduate units in astronomy including at least 6 units at the 500 level.

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

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

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

502. Astronomical Instrumentation Project (3) I 1991-92 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.


*May be convened with 400-level course.

515. Interstellar Medium and Star Formation (3) II 1992-93 Derivation of physical conditions from spectral data, ionized, atomic and molecular clouds, interstellar dust and magnetic fields. Ionization equilibrium, heating and cooling, shocks, dynamics, collapse and fragmentation, outflows and protostellar evolution.

518. Modern Astronomical Instrumentation and Techniques (3) I 1991-92 Radiant energy; signals and noise; detectors and techniques for image formation; photometry, polarimetry and spectroscopy. Examples from stellar and planetary astronomy in the x-ray, optical, infrared and radio. (Identical with Pys.S. 518)
Atmospheric Sciences (ATMO)

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

Professors E. Philip Krider, Head, George A. Dawson, Robert E. Dickinson, Robert L. Gall, Benjamin M. Herman, A. Richard Kasander, Jr. (Emeritus), Richard M. Schotland, William D. Sellers, Dean O. Staley
Associate Professor Kenneth C. Young
Assistant Professors Eric A. Betterton, Steven L. Mullen, 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 Physics in areas such as radiative transfer, remote sensing, atmospheric aerosols, atmospheric chemistry, cloud and precipitation physics, lightening and atmospheric electricity, atmospheric dynamics, mesoscale meteorology, and the modeling of global climate.

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

Degrees

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

Doctor of Philosophy: The Doctor of Philosophy with a major in atmospheric sciences is primarily a research degree. In addition to the requirements for the Master of Science degree, the candidate will be expected to demonstrate a proficiency in statistics and computer programming, complete at least 36 units of graduate course credit in the major field, 18 units of dissertation credit, and fulfill the minor requirement.

A dissertation based on original research is required. All Ph.D. students must pass a written and oral preliminary examination on his or her research. Doctoral students from other departments who wish to minor in atmospheric sciences must enroll in the graduate units of atmospheric science courses.

The department participates in the honors program.

521. Physical Climatology (3) II 1992-93 Heat and water balances of the earth-atmosphere system viewed from both the local and global scales; palaeoclimatology and theories of climatic change; man's impact on climate. P, 171

530. Micrometeorology (3) I 1991-92 Theoretical aspects of atmospheric turbulence, including discussions of laminar flow, turbulent flow, the mechanical energy equations, and the shearing stress and the wind profile. P, 441b

535. Air/Sea Interactions (3) I 1992-93 Physical characteristics of the oceans; the dynamics of ocean currents and their interactions with the atmosphere; El Nino 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. (Identical with Pty.S. 541a-541b)


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

560. Aerosol Science and Engineering (3) I 1991-92 (Identical with Ch.E. 560)


565. Mesoscale Analysis (3) II Description, analysis, and dynamics of weather systems of the mesoscale. Topics may include fronts, thunderstorms, gravity waves, lake effect storms and sea breezes. P, 471.

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

571. Synoptic Analysis and Weather Forecasting (4) I Principles of meteorological analysis and forecasting. Analysis of surface and upper-level charts, cross-sections and thermodynamic diagrams. Techniques for weather forecasting and actual forecasting experience including use of computer driven graphical displays. 1R, 6L. P, knowledge of Fortran or similar programming language; P, CR, 441a, or 300.

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

585. Tropospheric Chemistry (3) I 1991-92 Tropospheric chemistry of both the natural and polluted atmosphere. Topics include biogeochemical cycling of major constituents, urban air pollution and measurement techniques.
Teaching and research in biochemistry are carried out in several locations in the University and involve the efforts of the above-listed faculty members. These individual faculty members constitute the University Department of Biochemistry, which is responsible for instruction in biochemistry in the Colleges of Agriculture, Arts and Sciences, and Medicine.

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

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

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

505. Eukaryotic DNA Replication (3) [Rpt./1] I 1992-93 (Identical with C.Bio. 505)


543. * Research Animal Methods (3) (Identical with V.Sc. 543)
Biomedical Engineering

1326 E. Mabel Street
(602) 626-7559

Committee on Biomedical Engineering

Professors Peter H. Bartels (Optical Sciences, Pathology), Joseph F. Gross (Chemical Engineering, Physiology), Paul C. Johnson (Physiology), Murray A. Katz (Internal Medicine, Physiology), Kenneth C. Mylrea (Electrical and Computer Engineering), Robert Roemer (Aerospace and Mechanical Engineering), Bruce Simon (Aerospace and Mechanical Engineering)

Associate Professor Timothy W. Secomb (Physiology, ARL)

Biomedical engineering can be defined as a multidiscipline in which physical scientists and engineers interact with life scientists and physicians to solve problems ranging from basic biomedical engineering research to applications in clinics and health care delivery systems. The University Committee on Biomedical Engineering coordinates options available to students in the College of Engineering and Mines.

Graduate students working toward the Master 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. 565; E.C.E. 515, 517, 515; Ch.E. 585, 586; and S.I.E. 581. Additionally, courses in biomedical engineering are being developed, and supporting course work in the life sciences is also available. Collaborative research projects permit the student to participate in interdisciplinary associations which can enhance progress in the fields of biology, medicine, and engineering. Individual programs are determined by the student and an engineering departmental advisor.

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

Biophysics (BIP)

Biological Sciences West Building
Room 453
(602) 621-1224/626-6519

Committee on Biophysics (Graduate)

Professors R. P. Gruener (Physiology), Chair, H. H. Barrett (Radiology), M. F. Brown (Chemistry), P. M. Capp (Radiology), P. A. Carruthers (Physics), J. R. Cassady (Radiation Oncology), T. C. Cetas (Radiation Oncology), M. A. Cusanovich (Biochemistry), M. B. Denton (Chemistry), D. J. Donahue (Physics), J. H. Enemark (Chemistry), L. S. Forster (Chemistry), E. W. Gerner (Oncology), D. E. Gol (Animal Sciences), R. W. Gore (Physiology), J. F. Gross (Chemical Engineering), V. J. Hruby (Chemistry), P. C. Johnson (Physiology), J. O. Kessler (Physics), R. Kilksen (Physics), B. McNaughton (Psychology), N. H. Mendlson (Molecular & Cellular Biology), K. C. Mylrea (Electrical & Computer Engineering), L. Nadel (Psychology), D. F. O'Brien (Chemistry), R. B. Roemer (Radiation Oncology), D. G. Stuart (Physiology), G. Toltin (Biochemistry), R. S. Weinstein (Pathology)

Associate Professors: J. M. Burt (Physiology), L. M. Canfield (Biochemistry), T. P. Davis (Pharmacology), E.D. French (Pharmacology), R. J. Gillies (Biochemistry), A. F. Gmitro (Radiology), P. B. Hoyer (Physiology), D. L. Kreulen (Pharmacology), R. Clark Lantz (Anatomy), N. E. MacKenzie (Pharmaceutical Sciences, Biochemistry), T. W. Secomb (Physiology), D. Stein (Physics)

Assistant Professors: V. Guerrero, Jr. (Animal Sciences), B. A. Lulu (Radiation Oncology), R. Lynch (Physiology), W. R. Montfort (Biochemistry), S. S. Rossie (Pharmacology), M. C. Rykowski (Anatomy), P. St. John (Anatomy)

The graduate interdisciplinary program in biophysics offers the opportunity for study in a wide range of research areas which lie at the interface between physics and mathematics (in the physical sciences) and the biological sciences (for example: biochemistry, physiology, radiology). Because biophysics covers such a wide range of research topics, the program is designed for flexibility for students from the physical sciences with an interest in biology, and for biological sciences students with interests in applying quantitative approaches based in physics and mathematics. To accomplish this goal, faculty committee members with overlapping expertise in biological and physical sciences have been selected to direct thesis research.

Degrees

The Graduate Committee on Biophysics offers a major in biophysics for the Master of Science and Doctor of Philosophy degrees. Students may select a minor in several concentration areas in the biological as well as the physical sciences.

Admission Requirements

In addition to an undergraduate degree (ordinarily in the physical sciences), applicants should provide scores of the Graduate Record Examination. Three letters of recommendation, from faculty members, are required.

For additional information, contact Dr. R. P. Gruener.

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

681. Introduction to Biophysical Research (1-2) [Rpt. /3 units] I II $ Supervised research experiences in the labs of individual faculty members. 3-5L Open only to first-year majors.

696. Seminar
a. Biophysics I (1-2) [Rpt./8 units] I Open to majors only.
b. Biophysics II (1-2) [Rpt./8 units] II Open to majors only.

Botany

(See Ecology and Evolutionary Biology)
Committee on Business Administration

Professors William B. Barrett (Vice Dean), Chair, Louis A. Bier (Management and Policy), Gerald O. Bierwag (Finance and Real Estate), William L. Felix, Jr. (Accounting), Jay F. Nunamaker, Jr. (Management Information Systems)

Associate Professors Christopher P. Puto (Marketing), Stanley S. Reynolds (Economics)

Assistant Professor Assoo J. Vakharia (Management Information Systems)

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

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

Degrees

Master of Business Administration: For information concerning this degree see Requirements for Masters' Degrees in Business Administration elsewhere in this catalog.

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

Candidates must have a bachelor's degree and proficiency in mathematics at the level of Math. 125a or 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 discipline. The program requires a concentration in one of the fields available in the college: accounting, decision sciences, finance, management and policy, management information systems, and marketing. Minors are selected in a field which complements the major area of emphasis.

Business Economics

(See Economics)

Cancer Biology (CBIO)

Arizona Health Sciences Center
Room 0914
(602) 624-7749

Committee on Cancer Biology (Graduate)

Professors Eugene W. Gerner, Chair (Radiation Oncology), David S. Alberts (Internal Medicine), Harris Bernstein (Microbiology and Immunology), G. Tim Bowden (Radiation Oncology), Evan M. Hersh (Internal Medicine), Neil H. Mendelson (Molecular and Cellular Biology), David W. Mount (Molecular and Cellular Biology), Raymond B. Nagle (Pathology), E. E. Salmon (Cancer Center), I. Glenn Sipes (Pharmacology and Toxicology), Samuel Ward (Molecular and Cellular Biology)

Associate Professors Dan L. Brower (Molecular and Cellular Biology), Louise Canfield (Biochemistry), Anne E. Cress (Radiation Oncology), William S. Dalton (Internal Medicine), Carol Dieckmann (Biochemistry), Harinder S. Garewal (Internal Medicine), Mary J. C. Hendrix (Anatomy), John W. Little (Biochemistry, Molecular and Cellular Biology)

Assistant Professors Alison E. Adams (Molecular and Cellular Biology), K. S. Lam (Internal Medicine), Stanley P. L. Leong (Surgery), Roger L. Meisfeld (Biochemistry)

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

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

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

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

505. Eukaryotic DNA Replication (3) [Rpt./1]
1992-93 Molecular and biochemical aspects of DNA replication in mammalian cells will be described in conjunction with discussions of recent journal articles on selected topics. Includes the regulation of S phase within the eukaryotic cell cycle; nuclear organization during DNA synthesis; DNA replication enzymes; viral, yeast and embryo models of DNA replication; the initiation of DNA replication; DNA replication origins and the reconstitution of DNA replication complexes. P. Biol. 462b. (Identical with Biol. 505, M.C.B. 505, and Micr. 505)

551. Environmental Carcinogenesis (3) II 1991-92 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. 551 and R.Onc. 551)

555. Cancer Biology (3) II 1992-93 Fundamental biological aspects of neoplastic growth at the organ, cellular, and molecular levels; emphasis on the etiology, behavior, and therapy of neoplasms. (Identical with Anat. 555, I.Med. 555, Micr. 555 and R.Onc. 555)


596. Seminar h. Cancer Biology Series (1) I (Identical with R.Onc. 596h)

681. Introduction to Cancer Biology Research (2) I II 1992-93 Supervised research experience in the laboratories of individual faculty members.

851. Environmental Carcinogenesis (3) II 1991-92 For a description of course topics, see 551. (Identical with Micr. 851 and R.Onc. 851)


896. Seminar h. Cancer Biology Series (1) I (Identical with R.Onc. 896h)*

*Available on both 500 and 800 levels.

Chemical Engineering (CHE)

Geology Building, Room 120
(602) 621-2591


Associate Professor William P. Cosart
Assistant Professors Heli Campel, Cezar C. Czelt, Roberto Guzman
The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in chemical engineering. The graduate program is designed to provide advanced work in a core of transport phenomena, thermodynamics and reaction engineering with additional selected work in mass transfer, heat transfer, fluid dynamics, control theory, and process simulation. The following interdisciplinary options are also available: biomedical engineering, bioprocess engineering, energy systems engineering, and materials engineering. For details concerning these options see Engineering elsewhere in this catalog.

Degrees

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

Doctor of Philosophy: In addition to the requirements for the Master of Science degree, advanced work in mathematics, chemistry, physics, or other engineering fields is required. No foreign language is required. Teaching experience is a required part of each student's progress toward a Doctor of Philosophy degree with a major in chemical engineering. A minimum of one semester of teaching activity will be assigned each student during his/her studies.


505. Advanced Chemical Engineering Transport Phenomena (3) I Momentum, energy and mass transport in continua, solution of multidimensional problems, boundary layer theory, turbulence, second order theory. P. 305.

506. Advanced Chemical Engineering Thermodynamics (3) I Advanced applications of First and Second Laws, nonideal gases and liquids and their mixtures, principles of chemical equilibrium, and molecular theory. P. 420.


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

521.* Topics in Real-Time Computing (3) I Introduction to microcomputer and minicomputer-based real-time computing for data acquisition and process control. Includes study of various languages and operating systems. 2F, 3L.


532. Solid-Fluid Reactions (3) I Characterization of solid structural properties; principles of heterogeneous reactions involving a fluid and a reacting solid. P. 306 and 420, or M.S.E. 450R and 412. (Identical with M.S.E. 532)

535.* Corrosion (3) II (Identical with M.S.E. 535)

541. Industrial Energy and Power Management (3) II (Identical with N.E.E. 541)

548. Combustion Generated Air Pollution (3) II (Identical with A.M.E. 548)

551.* Chemical and Physical Fundamentals of Air Pollution (3) II Study of the kinetics, transport phenomena and phase equilibria of urban air pollution problems. 3ED. P. 305, 420.


560. Aerosol Science and Engineering (3) I 1991-92 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 Atmo. 560 and E.C.E. 560)

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

570.* Fundamentals of Polymeric Materials (3) II Fundamental chemical, physical, and mechanical properties of organic plastics, fibers, coatings, adhesives, and elastomeric polymers.

580.* Bioseparation Techniques for Engineers (3) II Methods of separation for purification of bioprocess products—amino acids, proteins, nucleic acids, carbohydrates, lipids, cells.

581.* Bioreactor Engineering (3) I Introduction to biotechnology; chemistry of microorganisms; design of bioreactors to include cellular and enzyme reactors of all types; transport phenomena and control of bioreactors, instrumentation and measurement in bioreactors.

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


645. Advanced Solar Engineering (3) II (Identical with N.E.E. 645)


Chemistry (CHEM)

Old Chemistry Building, Room 227 (602) 621-6343


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 adviser. The committee administers examinations for all new students during the week before registration each semester. These examinations cover various branches of chemistry, and the results are used to help students plan an appropriate graduate program.

Degrees

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

Master of Science: A thesis based upon original research is required. All students must pass a final oral examination.

Master of Education: See Master of Education elsewhere in this catalog.

Doctor of Philosophy: The Doctor of Philosophy with a major in chemistry is primarily a research degree. The number and selection of courses is tailored to the individual student’s needs and interests according to the guidelines available from the Office of Academic Affairs in the Department of Chemistry. The minor work may be satisfied within the Department of Chemistry. 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.


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.

507. Radiochemistry and Radiation Detection (3) I (Identical with N.E.E. 507)

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

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

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


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

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

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

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

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


527. Analytical Separations (3) I Fundamentals of separation processes—single and multistage; differential migration methods.

528. Advanced Instrumental Laboratory (2) I Laboratory experiments in spectrophotometry, emission spectrometry, chromatography and electroanalysis. 6L. P. CR, 521.

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


560. General Biochemistry (5) I (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)

565. Enzymes (3) II 1992-93 (Identical with Bioc. 565)

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

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

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

583. Chemical Kinetics (3) II Classical and modern techniques in studies of chemical reactions. P. 480b.

584. Practical Nuclear Magnetic Resonance Spectroscopy (3) I Theoretical and practical aspects of the operation of nuclear magnetic resonance spectrometers and interpretation of NMR spectra. P. 480b.

591. Preceptorship

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

Note: A combination of 591a, 591b, or 591c may be taken up to a total of 6 units.

591a. * Chemistry Course Development (1) [Rpt./2 units] I II S

591b. * Professional Service (1) [Rpt./2 units] I II S

591c. * Professional Service (1) [Rpt./2 units] I II S

597. Radiochemistry and Radiation Detection (3) I (Identical with N.E.E. 507)

615. Coordination Chemistry (3) I Selected topics in the area of coordination compounds of transition metals, with particular emphasis on ligand field theory, the symmetry aspects of the spectral properties of transition metal complexes and their magnetic behavior. P. 510b or CR.

618. Computations in Chemistry (3) [Rpt./1] State-of-the-art computational methods in chemical research, including approximate and ab inito electronic structure methods, molecular mechanics, and modeling graphics. 2R, 3L. P. consult department before enrolling.

640. Advanced Organic Synthesis (3) II Theory 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 Synthesis, stereochemistry, and mechanisms of formation of high polymers. 642a: Condensation and ring-opening polymers. 642b: Vinyl polymers. P. 540. 642a is not prerequisite to 642b.

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

645. Chemistry of Natural Products (3) I Isolation, structural elucidation, total synthesis, biosynthesis, metabolism, and physiological importance of natural products. P. 540.

646. Advanced Organic Chemistry (3) [Rpt.] I II Advanced topics in organic chemistry, such as peptide chemistry, computer simulations, bio-organic chemistry, and other topics characterized by faculty expertise. Topics will vary each semester. P. consult department before enrolling.
680. Quantum Chemistry (3) II Principles of quantum mechanics with applications to the properties of molecules. P. 580.
687. Molecular Spectroscopy (3) I Applications of quantum mechanics to the interpretation of the spectra of molecules of chemical and biological interest. P. 580.
695. Colloquium a. Chemical Research Opportunities (1) I b. Exchange of Chemical Information (1 to 3) [Rpt./7 units] II S
696. Seminar a. Analytical Chemistry (1 to 3) [Rpt./8 units] II b. Inorganic Chemistry (1 to 3) [Rpt./8 units] II c. Organic Chemistry (1 to 3) [Rpt./8 units] I d. Physical Chemistry and Chemical Physics (1 to 3) [Rpt./8 units] I II
697. Workshop a. Chemical Instruments (1 to 3) II

Chinese
(See East Asian Studies)

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

Associate Professors Curtis W. Bryant, Munirah Budhu, Mohammad R. Ehsani, Donald B. Hawes (Emeritus), Tribikram Kundu, Margaret S. Petersen (Emeritus), Robert H. Wortman
Assistant Professors Sonia H. Armaleh, Robert G. Arnold, George Frankziskonis, William M. Ishenower, Panos D. Kicous, Kevin E. Lansley, Bruce E. Logan, Hamid Saadatmanesh

The department offers programs leading to the Master of Science and the Doctor of Philosophe 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, hydraulic and fluid mechanics, environmental engineering, geomechanics, geotechnical engineering, water resources, structural engineering, and transportation. Certain interdisciplinary options are available by combining various areas of the program. For further information concerning these options see Engineering elsewhere in this catalog.

Degrees

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

Doctor of Philosophy: A minor field may be selected from architecture, chemistry, geology, mathematics, mechanical engineering, materials science and engineering, mining engineering, nuclear engineering, physics, or systems engineering, or from within the Department of Civil Engineering and Engineering Mechanics.

Still other fields are available as minors with the approval of the head of the department.

Civil Engineering (CE)

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 and environmental engineering, structural engineering, soils engineering, transportation engineering, surveying and mapping, and urban planning and engineering.

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

502.* Introduction to Finite Element Methods (3) II Theory and formulation procedures: energy and residual; one-dimensional problems; stress analysis in axial structures, steady and transient fluid and heat flow, consolidation, wave-propagation, beam-column; two-dimensional problems: field and plane/axisymmetric; use of computer codes for solution to typical problems. P. 302. (Identical with E.M. 502)

503. Subsurface Fluid Dynamics (3) I (Identical with H.W.R. 503)

504. Numerical Methods in Subsurface Hydrology (4) II (Identical with H.W.R. 504)

517. Mechanics of Materials II (3) Three-dimensional analysis of stress and strain, Castigliano's theorems, curved beams, asymmetric bending, shear center, torsion of thin-walled sections, beams on elastic foundation, non-linear material behavior, membrane stresses in shells. P. 217.

521. River Engineering (3) II River geomorphology, stabilization and rectification of alluvial rivers, canalization, waterborne commerce, impacts of river engineering works. P. 322.

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

523.* Hydrology (3) I Discussion and analysis of major topics of the hydrologic cycle and their interrelationship, such as rainfall, infiltration, evaporation, and runoff. Statistical and probabilistic methods in water supply and flood hydrology. P. 321 (Identical with H.W.R. 523)

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


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

529. Analysis by Hydraulic Models (3) II 1990-91 Types and theories of models. Advantages, distortions, limitations, interpretation of models, with examples and case studies. P. 322.

532.* Advanced Structural Design in Steel (3) I Advanced problems in the analysis and design of steel structures including beam columns, plate girders, composite construction, multi-story buildings; seismic and dynamic lateral and vertical loads; connections; computer applications. P. 336.

533. Plastic Analysis and Design (3) II Material and member behavior to full plastification; redistribution of forces; plastic design of continuous beams and frames; influence of axial and shear forces; deflections and rotations; alternating plasticity; shakedown analysis. P. 432 or consult department before enrolling.

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

540.* Foundation Engineering (3) II Settlement and bearing capacity of shallow and deep foundations; beam on elastic foundation; design of footings and pile foundations; foundations on metastable soils; the use of computer codes for foundation problems. P. 340.

541.* Stability Problems in Geotechnical Engineering (3) I Stability analysis for earth slopes, including planar, circular piecewise-linear, and composite-surface methods: analyses for static and steady-flow conditions; earth pressure theories and calculations for pre- and post-landsliding conditions; design of rigid and flexible retaining structures; design of braced and tie-back shoring systems; design of reinforced earth walls; computer-aided analysis and design. P. 340.

544. Soil Stabilization (3) II Purpose of soil stabilization; stabilization using mechanical means, cement, asphalt, lime, salt and resins; factors governing stabilization techniques; special application. P. 340.
547. Seeage and Earth Dams (3) I Principles of flow in porous media; analytical and approximate solutions of confined and unconfined flow; seepage, erosion, piping and filter design; earth and rock fill dam construction and design; stability analyses. P. 340.

548. Numerical Methods in Geotechnical Engineering (3) I Brief statements and applications of numerical methods based on closed-form solutions, finite difference, finite element and boundary element methods for problems involving soil structure interaction such as piles, retaining walls, group piles, underground works; seepage; and consolidation. P. 340, 402 or 502.

552.* Engineering Surveys (3) I Solar and Polaris observations; mineral, public, and private land surveys; route surveying, curves, and earthwork; triangulation, photogrammetry, and modern engineering surveys. P. 251.

555.* Irrigation Engineering (3) II (Identical with A.B.E. 555)

556.* Drainage of Irrigated Lands (3) II (Identical with A.B.E. 558)

561. Ground-Water Management (3) II (Identical with H.W.R. 561)

562.* Bituminous Materials (3) II Manufacture and evaluation tests for the control of bituminous materials used in highway construction and maintenance. P. 340, or consult department before enrolling.

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

564.* Airport Planning and Design (3) II Location, analysis and design of airports and airport facilities, including aircraft characteristics, site selection, configuration, capacity, access and terminals. Field trips. P. 360.

565.* Project Planning and Modeling (3) II Use of systems analysis in contemporary planning, including consideration of social, environmental and physical constraints; study of general and special purpose manual and computer-based simulation and gaming as an engineering and planning tool. P. senior standing in civil engineering or consult with department. (Identical with Png. 565)

568.* Urban Transportation Planning (3) II Transportation planning in relation to urban development; techniques and procedures for developing long-range regional plans. P. 360 or consult department before enrolling. (Identical with Png. 568)

571.* Water Quality Control (3) II Aspects of water quality maintenance; physical, chemical and biological factors in water and wastewater treatment and natural purification. 2R, 3L. Degree credit available for nonmajors only. P. Chem. 103b. (Identical with H.W.R. 571 and Ws.M. 571)

573. Biodegradation of Hazardous Organic Compounds (1-2) I Chemical and microbiological considerations which affect the thermodynamics and kinetics of transformations of hazardous organic compounds in treatment facilities and in natural settings. 1R, 3L. P. 577, or consult with department.

574. Chemical Transport in Environmental Processes (3) I Engineering concerns in toxic and hazardous waste management with focus on aspects of chemical transport between air, water and soil systems, and microbial degradation processes in the natural environment.

575. Microbiology of Environmental Engineering (3) I Microbiological concepts and their application to natural and engineered systems for upgrading water and wastewater quality. 2R, 4L. P. 570.

576.* Chemistry of Environmental Engineering (3) I Chemistry of natural waters and water and wastewater treatment processes. Chemical thermodynamics, equilibria and kinetics are applied to environmental systems. P. Chem. 103b, Math. 254.

576.* Environmental Chemistry Laboratory (1) I Laboratory exercises emphasizing the chemistry of natural waters, water and wastewater including related analytical methods. 3L. CR. 576R.

577. The Physiological Bases of Microbial Treatment Processes (3) II Principles of bacterial physiology including morphology, metabolism and genetics. Applications of importance to waste treatment and environmental quality. P. 370, or consult with department.

578.* Introduction to Hazardous Wastes (3) I II Management, planning, legal and engineering aspects of liquid and solid hazardous waste treatment and disposal. P. 370 or 471, or consult department before enrolling.

579. Environmental Air Pollution (3) I Air pollution sources and pollutant control, with special consideration of the meteorological, urban, rural, industrial, and health aspects. P. 566.* Fundamentals of Industrial Hygiene (3) I (Identical with O.S.H. 566)

587.* Advanced Industrial Hygiene and Safety (3) II (Identical with O.S.H. 587) *May be convened with 400-level course.

596. Seminar a. Sanitary and Environmental Engineering (1-3) II Geomechanics/Engineering (1) [Rpt.2] II (Identical with H.W.R. 596b)

610. Probability in Civil Engineering (3) I (Rpt.) Outline the extent of uncertainties under which civil engineering designs and decisions are made. Theory and application. Advanced topics in risk-based engineering design. System reliability concepts. Statistical decision theory and its application in civil engineering. Identifying and modeling nondeterministic problems in engineering in understanding many recently issued engineering codes. P. consult department before enrolling.

613. Theory of Elastic Stability (3) II Bending and buckling of prismatic bars, beams, rings, curved bars, thin shells, and thin plates under axial and lateral loads. P. 417 or E.M. 603 and C.E. 402, or consult department before enrolling.

621. Sediment Transportation (2) I Erosion, transportation and deposition of sediments by flowing water; sediment properties and their measurement; bed load and suspended load movement; river behavior and control. P. 321.

622. Open-Channel Flow (3) I Continuity, energy and momentum principles applied to steady and unsteady flow in open channels: channel controls, transitions, flood routing, and models. P. 322.

623. Flow through Hydraulic Structures (3) II 1990-91 Subcritical and supercritical flow through culverts, bridges, spillways, stilling basins, transitions, bends; hydrologic effects on inflow: pumps and turbines. P. 522.

624. Planning and Design of Multipurpose Water Resources Projects (3) I (Rpt.) Design of water resource systems for surface water supply, flood control, hydropower and navigation, either as single purpose or as multipurpose projects; brief review of environmental, economic and legal aspects. Field trips. P. 321, 423 or 523.

633. Reinforced Concrete Members (3) I Inelastic behavior of beams and columns; short- and long-term beam deflections; combined bending, shear, and torsion in beams; behavior under load reversals; analysis and design of beam to column connections and shear walls. P. 437 or departmental approval.

637. Soil-Structure Interaction (3) I 1991-92 Explanation of soil-structure interaction, closed form and numerical solutions, beams, axially and laterally loaded piles and walls, wave equation for piles, group piles, slabs on deformable media. P. 640 or 641 or consult department before enrolling.

640. Advanced Soil Mechanics (3) I Site investigation and in situ testing; shear strength of sands and clays; interpretation of laboratory test results; consolidation theory: one-dimensional infinismals and finite strain; slope stability. P. 340.


642. Engineering Characteristics of Soil (3) II Advanced theories of mechanical and physical aspects of soil. Lab testing including index parameters, compaction, consolidation, shear strength; introduction to critical state and plasticity aspects. 1R, 6L. P. 640.


648. Constitutive Laws for Engineering Materials (3) II Statement of axioms of continuum mechanics. Strain, stress and nonlinear behavior. Laboratory testing including hyperelasticity, hypoelasticity, rate type models, plasticity review, hardening, volume change and dilatancy, softening, inherent and induced anisotropy. Laboratory testing and implementation. P. E.M. 505, 603, or consult department before enrolling. (Identical with E.M. 648)


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

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

664. Transportation Economics (3) I Economic analysis of transport projects, including rural and urban roads, control systems, and mass transit; discussion of environmental and financial factors. P. 463 or 563.

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

666. Highway Geometric Design (3) II Study of geometric elements of streets and highways, with emphasis on analysis and design for safety. P. 463 or 563.

667. Traffic Operations and Safety (3) II Application of traffic control devices for street and highways, design of traffic control systems, analysis and management of highway traffic, evaluation of safety. P. 463 or 563.

668. Urban Public Transportation Systems (3) I Development, operation, management, financing, evaluation and travel demand estimation for urban public transportation systems. (Identical with Ping. 568)

673R. Advances in Water and Waste Reclamation and Reuse (3) II Theory, application, and evaluation of currently developing techniques in water and waste reclamation and reuse. P. 675.

673L. Advanced Water-Wastewater Treatment Laboratory (1) II Experiments in physical-chemical treatment of water and wastewater designed to illustrate treatment principles in that subject area. 3L. CR, 673R.

674. Toxic and Hazardous Waste Treatment (3) II The process engineering fundamentals from which treatment strategies and process treatment trains can be synthesized to control toxic and hazardous wastes. Both traditional and emerging technologies will be considered. Emphasis will be placed on integrated water, air and land interfacial environmental interactions. Field trips. P. 574, or consult with department.

675R. Wastewater Treatment (3) I Theoretical and applied principles of aerobic and anaerobic wastewater treatment systems. P. 370.

675L. Wastewater Treatment Laboratory (1) I Experiments in biological treatment of wastewater and anaerobic digestion designed to illustrate treatment principles. 3L. CR, 675R.

676R. Advanced Water Treatment System Design (3) II Design and operation of water treatment plants; physicochemical treatment processes for potable water production.

676L. Water Treatment System Design Laboratory (1) II 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 and environmental engineering, structural engineering, soils engineering, transportation engineering, surveying and mapping, and urban planning and engineering.

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

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

505. Continuum Mechanics (4) I Analysis of deformation, principal stresses and strains, velocity fields, and rate of deformation; constitutive and field equations; elementary elasticity. P. C.E. 417, or consult department before enrolling.

508. Fracture Mechanics (3) II 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. 505, or consult with department.

511. Advanced Finite Element Analysis (3) II Approximation functions, Lagrangian and Hermite interpolation, isoparametric elements and numerical integration; mixed, hybrid and boundary element methods, nonlinear analysis, nonlinear problems in solids under static and dynamic loads, time integration schemes, fluid and heat flow coupled problems and mass transport. P. 402, or consult department before enrolling. (Identical with A.M.E. 511)

596. Seminar

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

603. Elasticity Theory and Application (3) I General three-dimensional equations of elasticity; problems in plane stress, plane strain, extension, torsion; energy and residual (Galerkin) methods; applications to rings, beams, plates, torsion and other problems. P. C.E. 217, 302.

604. Plasticity Theory and Application (3) II Yield conditions and flow rules for perfectly plastic and strain hardening materials; application to various elastoplastic problems such as bars, cylinders and plates; effect of volume change behavior, isotropic and anisotropic hardening plasticity with expanding/contracting yield surfaces. P. C.E. 417 or E.M. 603, or consult department before enrolling.


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. 461.

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. 356 or A.M.E. 324.


648. Constitutive Laws for Engineering Materials (3) II (Identical with C.E. 649)

Classics (CLAS/GRK/LAT)

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

Professors Norman Austin, Albert Leonard, Jr., David Soren
Associate Professors Thomas D. Worthen, Acting Head, Richard C. Jensen, Jon Solomon Assistant Professors Holt Parker, Mary Voyatzis

The Department of Classics offers a degree of Master of Arts with concentrations in philology (Greek/Latin) and classical archaeology. The graduate courses are open to all graduate students with the permission of the instructor.

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) [Rpt./1] Analysis of Greek prose style and practice in composing Greek prose. P. 3 units of 400-level Greek.

512.* Readings in Greek Philosophy (3) [Rpt./1] Extensive readings in Greek in one of the following areas of Greek philosophy: the pre-Socratics, Plato's ethics and epistemology, Aristotle's Nicomachean Ethics, P. 3 units of 400-level Greek. (Identical with Phil. 512)

521.* Greek Lyric Poetry (3) [Rpt./1] Study in Greek of the early Greek lyric writers from Archilochus to Bacchylides, including Pindar. P. 3 units of 400-level Greek.

522.* Readings in Greek Drama (3) [Rpt./1] Close reading of Greek of either (1) tragedy— one play each by Aeschylus, Sophocles and Euripides or (2) comedy— two plays of Aristophanes, one of Menander. P. 3 units of 400-level Greek.

524.* Homer (3) [Rpt./1] Close reading of selections from the Iliad and Odyssey in Greek and an introduction to the critical secondary literature.

530.* Readings in the Greek Historians (3) [Rpt.] Selections from Herodotus and Thucydides with an introduction to the critical literature. Readings in Greek. P. 3 units of 400-level Greek.

531.* Greek Orators (3) [Rpt.] Readings in Greek from Lysias, Isocrates and Demosthenes as sources for ancient rhetoric, politics, and private life. P. 3 units of 400-level Greek.
532.* Literature of Archaic Greece (3) [Rpt.]
Readings in Greek from Hesiod and the early lyric poets. The agricultural perspective and the anti-heroic ideal. P. 3 units of 400-level Greek.

*May be convened with 400-level course.

596. Seminar
a. Ancient Greek Literature (3) [Rpt./30 units]

Latin (LAT)

501.* Latin Reading Course (3) [Rpt./3] Readings in one of the following: epic, lyric, drama, history, oratory, satire, epistles, novels, philosophical, technical or medieval literature. P, 3 units of 400-level Latin.


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

514.* Medieval Latin (3) Survey of Latin literature during the thousand years between the end of the classical period and the beginning of the Renaissance. Readings in Latin. P, 3 units of 400-level Latin.


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.

520. Latin Paleography (3) Identification and reading of major Latin bookhands of the Middle Ages and the Renaissance. Problems in text transmission, corruptions and emendations. P, 3 units of Latin at the 400 level.

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

525.* Cicero (3) [Rpt./3] The life of Cicero illustrated by means of close reading of selected works in Latin (pro Caelo, selections from the Philippics, the Verrine Orations) as well as selections from his letters. P, 3 units of 400-level Latin.

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

528.* Silver Age Latin (3) [Rpt.] Readings from Latin writers of the early Empire. Selections will be drawn from Petronius, Martial, Lucan, and Apuleius. P, 3 units of 400-level Latin.

*May be convened with 400-level course.

550. Classical Literature and Civilization (CLAS)


570.* Greek Philosophy (3) [Rpt./1] (Identical with Phil. 570)

572a-572b.* Ancient Philosophy (3-3) [Rpt.] (Identical with Phil. 572a-572b)

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

588.* History of Byzantium (3) (Identical with Hist. 598)

*May be convened with 400-level course.

595. Colloquium
f. Advanced Studies in Ancient History (3) [Rpt./5] II (Identical with Hist. 595f, which is home)

Classical Art and Archaeology (CLAS)

543a-543b.* Archaeology of Neolithic and Bronze Age Greece (3-3) History, art and culture of prehistoric Greece through the study of archaeological excavations. 543a: Paleolithic through the end of the Middle Bronze Age. 543b: The Minoan and Mycenaean cultures of the Late Bronze Age. 543a is not prerequisite to 543b. P, 6 units in classics, history, or anthropology. (Identical with Anth. 543a-543b).

553.* Research Methods In Classical Archaeology (3) Analysis of various methods of research in classical archaeology emphasizing the critical use of source material, the development of independent thought and the production of the finished, written product. P, 340a or 340b.

554.* Greek and Roman Sculpture (3) A survey of the development of classical sculpture from the eighth century B.C. to circa 300 A.D. P, 340a-340b. (Identical with Arch. 554)

556.* Greek and Roman Painting (3) Greek vase painting from the Dipylon vases of the geometric period in Athens to the Orientalizing animal styles of Corinth and the black and red figured Attic style. Also, survey of ancient Roman painting and mosaics. P, 340a-340b. (Identical with Arch. 556)

557.* Greek Architecture (3) A survey of the architecture and architects of Greece from the Neolithic to Roman periods including such sites as Nea Nikomedia, Aegina, Lerna, Tiryns, Mycenae, Athens and Corinth. P, 340a-340b. (Identical with Arch. 557)

558.* Greek and Roman Provincial Archaeology (3) Survey of classical archaeology in ancient Tunisia, Cyprus, Portugal and Turkey. P, 340a or 340b.

561.* Archai Greek Sanctuaries (3) Archaeology of the sanctuary sites from the Archaic Period in Greece, both those which became panhel lenic and those associated with individual states. Relationships between the polis and the local sanctuary. (Identical with Anth. 561)

563.* Classical Field Archaeology (3) [Rpt./1] Field training and lecture program for students beginning in archaeology; includes trench supervision, stratigraphy, locus theory, and oral and written reports on field techniques. Offered on several archaeological sites in the Mediterranean area. P, consult department before enrolling.

564. Topics in 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.

565. Topics in Greek and Roman Architecture and Urbanism (3) Research papers on an aspect of ancient architecture which involves not only monuments themselves but attempts to consider a building in its physical and cultural setting. P, 340a or 340b.

581.* Greek Pottery 1200-400 B.C. (3) The development of Greek pottery from the collapse of the Mycenaean empire to the close of the classical period. Special attention to shapes, decoration, function, and artistic and technical skills. (Identical with Anth. 581)

584.* Roman Art and Architecture (3) The origin and development of Italian art and architecture from Etruscan beginnings through the Republic to the late Empire. P, Art 117, 118, or 6 units of ancient history. (Identical with Arch. 584)

589.* Topography and Monuments of Athens (3) I 1992-93 Analysis of the historical and archaeological evidence for the development of the city of Athens from the Neolithic Period through Roman times. P, 340a or 340b; consult department before enrolling.

*May be convened with 400-level course.

596. Seminar
a. Aegean, Roman and Mediterranean Provincial Archaeology (3) [Rpt./30 units]

Clinical Engineering
(See College of Engineering and Mines)

Psychology Building, Room 312
(602) 621-2065

Committee on Cognitive Science (Graduate)

Professors Merrill Garrett, Chair (Linguistics, Psychology, Speech and Hearing Sciences), Carol Barnes (Psychology, Neurology), Robert Cummins (Philosophy), Richard Demers (Linguistics), Kenneth I. Forster (Psychology), Alvin I. Goldman (Philosophy), Michael M. Harish (Philosophy), Thomas J. Hixon (Speech and Hearing Sciences), William Ittelson (Psychology), Alfred W. Kasznik (Neuroscience), John F. Kohlstrom (Psychology), D. Terence Langdon (Linguistics), Adrienne J. Lehrer (Linguistics), Bruce L. McNaughton (Psychology, Physiology), Lynn Nadel (Psychology), John L. Pollock (Philosophy), Alan B. Forster (Psychology), Robert Cummins (Philosophy), Richard Demers (Linguistics), Kenneth I. Forster (Psychology), Alvin I. Goldman (Philosophy), Michael M. Harish (Philosophy), Thomas J. Hixon (Speech and Hearing Sciences), William Ittelson (Psychology), Alfred W. Kasznik (Neuroscience), John F. Kohlstrom (Psychology), D. Terence Langdon (Linguistics), Adrienne J. Lehrer (Linguistics), Bruce L. McNaughton (Psychology, Physiology), Lynn Nadel (Psychology), John L. Pollock (Philosophy), Alan B.
The committee offers a minor in cognitive science for the Doctor of Philosophy degree. Inquiries should be directed to the chairman of the Committee on Cognitive Science at the campus address given above.

**Communication (COMM)**

Speech Building, Room 209 (602) 621-1366

Professors Michael Burgoon, Head; Judee K. Burgoon, Henry L. Ebanks, Jr.; Klonda Lynn (Emerita), Alethea S. Mattingly (Emerita), Lee Sigelman (Political Science)

Associate Professors David B. Buller, James W. Davis, Sally Jackson, Curtis S. Jacobs, Henry C. Kenski, Jr. (Political Science), Robert W. Sankey, David A. Williams

Assistant Professor Calvin Morrill (Sociology), Tamra Pearson d’Estree

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in communication. Work leading to the Master of Education degree with a major in communication also is offered in cooperation with the College of Education.

Four program options are available for the Master of Arts degree, the departmental program with a thesis or nonthesis option and the interdisciplinary program with thesis or nonthesis. The thesis option requires a minimum of 31 units, including four thesis units; 36 units are required in the nontesis alternative. Those electing a departmental program may count a maximum of three units taken outside the department toward the required minimum. Those electing an interdisciplinary program (e.g., organizational communication concentration) must take a minimum of nine units outside the department. These nine outside units must provide the student with a coherent concentration in a specific area outside the department and be approved by the Director of Graduate Studies. The nine units of independent study may be included in the required minimum.

Doctoral students must complete at least 36 units of coursework in the major (including up to nine units from the master's degree), one or two minors, plus the dissertation, and must demonstrate proficiency in a scholarly research tool. A maximum of six units of independent study, not including those counted toward the Master of Arts degree, may be included in the required minimum for the major and minor.

Students in the master's program are required to complete courses 610, 620, and 660 plus an additional research methods course. Doctoral students are required to complete courses 610, 620, 660 and 670. For both masters and doctoral students, all courses to be counted toward the minimum hours requirements must carry a grade of B or better (or P or better for S/P Special Grades).

In addition to the materials required by the Graduate College, applicants for admission must file with the department a departmental application form, three letters of recommendation, and Graduate Record Examination scores that are no more than five years old. Applicants for the doctoral program must submit a master's thesis or other evidence of scholarly writing.

503.* Theories of Small Group Communication (3) I II Theory and research on social control and deviance in groups from the perspective of communication behavior.

509.* Theories of Mass Communication (3) I II In-depth analysis of theories of the social effects of various mass media sources on society.

510.* Struggle for the Presidency (3) I Examination of the campaign strategies and tactics of those seeking the nation's most powerful office from 1960 to the present. (Identical with Pol. 510)

511.* Communication and Conflict Management (3) I II Consideration of theory and research pertaining to the handling of conflict across diverse contexts.

515.* Nonverbal Communication (3) I II Theory and research on nonverbal communication codes (kinesics, touch, voice, appearance, use of space, time and artifacts) and social functions (impression formation and management, relational communication, emotional expressions, regulation of interaction, social influence).

517.* Relational Communication (3) I II The relational communication process and messages people use to define interpersonal relationships, including dominance-submissiveness, affection, involvement and similarity. P. 104.

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 processes. (Identical with Soc. 520)

521.* Political Campaign Communication (3) I Investigation and analysis of communication principles and practices in contemporary campaigns for elective office.

522.* Presidential Leadership and Communication (3) I II Examination of presidential leadership and communication strategies of the modern presidents from Kennedy to the present.

523.* Topics in Rhetorical Theory and Criticism (3) I II Intensive reading and analysis of the works of major rhetorical theorists. Each semester will focus on a specific era or perspective.

528.* Communication Research Methods (3) I II Theories of communication and research methods; research methodology in communication behavior studies.


552.* Communication and Human Relationships (3) S An advanced course enabling students to inventory, evaluate, and develop oral communication skills in the interpersonal, group, and organizational dimensions of their lives.

*May be convened with 400-level course.

559. Scholarly Communication (3) I II (Identical with L.S. 569)

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 development of interpersonal relationships.

620. Communication Theory II (3) I II An overview of historical and theoretical 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.

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

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

671. Research Methodologies III (3) I S Issues in measurement and sampling in laboratory and field research in communication. P. 870.

696. Seminar

a. Nonverbal Communication (3) [Rpt./3] I II
b. Literature as Communication (3) [Rpt./3] I II
c. Rhetorical Theory and Criticism (3) [Rpt./3] I II
d. Social Influence (3) [Rpt./3] I II
e. Mass Media (3) [Rpt./3] I II
f. Linguistic Investigations and Applications (3) [Rpt./3] I I (Identical with Ling. 696f)
g. Message Analysis (3) [Rpt./3] I II
h. Organizational Communication (3) [Rpt./3] I II
i. Interpersonal Communication (3) [Rpt./3] I II
j. Information Processing and Management (3) [Rpt./3] I II
k. Research Methods (3) [Rpt./3] I II
Comparative Literature and Literary Theory (CPLT)
1249 North Highland Avenue, Building 431c
(602) 626-8693

Committee on Comparative Literature and Literary Theory (Graduate)

Professors J. Douglas Canfield, Chair (English), Susan H. Aiken (English), Norman Austin (Classics), Barbara A. Babcock (English), Jonathan Beck (French and Italian), David H. Chisholm (German), William Epstein (English), Lawrence J. Evers (English), Adel Gamal (Near Eastern Studies), John Garrard (Russian and Slavic Languages), Robert M. Gimello (East Asian Studies/Religious Studies), Jerrold E. Hogle (English), Richard P. Kinkade (Spanish and Portuguese), Annette Kolodny (English), N. Scott Momaday (English), Suresh Raval (English), Eliana S. Rivero (Spanish and Portuguese), Herbert N. Schneidau (English), Charles Tatum (Spanish and Portuguese)

Associate Professors Esther Fuchs (Judaic Studies), Ingeborg Kohn (French and Italian), Steven D. Martinson (German), Ronald C. Miao (East Asian Studies), Judith A. Nantell (Spanish and Portuguese), Charles Sherry (English), Jon Solomon (Classics), Thomas Spaulding Willard (English), Linda Zwinger (English)

Assistant Professors Marie Chan (East Asian Studies), Albrecht Classen (German), Irene D’Almeida (French and Italian), Susan Derwin (English), Barbara Kosta (German), Lise Leibacher (French and Italian), Tenney Nathenson (English), Holt Parker (Classics), Susan White (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, East Asian Studies, English, French and Italian, German, Judaic Studies, Near Eastern Studies, Russian and Slavic Languages, and Spanish and Portuguese. 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; and (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 (available now only in English); (c) GRE Subject test in another literature, or (d) GSPFLT exam in a second language; and (e) TOEFL exam for foreign students.

Master of Arts: Degree requirements include at least 30 units: 18 units in graduate-level literature courses in at least two original languages; no more than 9 units may be taken in the student’s native language; 6 units of 503a-503b; 3 units of independent study in preparation for the master’s examination; 3 units of 550a final examination evaluated by the Executive Committee, augmented by at least one specialist in the area of the paper.

Doctor of Philosophy: Degree candidates are required to take at least 42 units for the major, 18 units of dissertation, and a minor. Course 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, or American Indian studies) or an interdisciplinary combination. If a discipline is chosen and one of the student’s literatures under (a) above is in his or her native language, the student must pass a reading exam in a second foreign language.

Minor: Supporting areas of study will be approved by the CPLT 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 East and West. 503a: Theories of representation in the West. 503b: Non-Western theories of literature (Amerind, Chinese, Japanese, Indian, and Arabic). 503a is identical with Engl. 503a; 503b is identical with E.A.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 1992-93 (Identical with Ling. 561)

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

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

Professors Gregory R. Andrews, Head, Ralph E. Griswold, Udi Manber
Associate Professors Peter J. Downey, Stephen R. Mahaney, Eugene W. Myers, Richard D. Schlichting, Richard T. Snodgrass
Assistant Professors Mary Bailey, Saumya K. Debray, Scott E. Hudson, Norman C. Hutchinson, Sanjay Manchanda, 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 prepare 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, theory, analysis of algorithms, databases, computer networks, and computer graphics.

Applicants for admission should hold an undergraduate degree in computer science or a related field. In addition to the application materials submitted to the Graduate College, applicants must submit to the department scores from the General Test of the Graduate Record Examination. Scores for the Computer Science Subject test are strongly recommended. The department requires that two letters of recommendation be submitted.

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

Master of Science: 30 units of graduate credit are required, including the core courses 552, 553, 573, four specialization courses, and at least one advanced electives course. A thesis is not required, but with departmental approval a student may elect to submit one.

Doctor of Philosophy: Doctoral students must complete 36 units of graduate credit in the major including the M.S. core, 520, 545, and 576, and at least two advanced topics. Course work in a related minor field is required. There is no foreign language requirement.

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


520. Principles of Programming Languages (3) Important programming language concepts, including types, control and data abstraction, denotational semantics, declarative and object-oriented languages, implementation issues. P. 453.

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

522. Principles of Concurrent Programming (3) Fundamental concepts of concurrent programming; synchronization mechanisms based on shared variables and message passing; systematic development of correct programs; paradigms for distributed programming. P. 373, 452.

525. Principles of Computer Networking (3) Theory and practice of computer networks, emphasizing the principles underlying the design of network software and the role of the communications system in distributed computing. Topics include data representation, channel semantics, synchronization, resource naming, and resource sharing. P. 452.

530. Software Design (3) I Techniques and tools for program design and implementation, especially of large programs. Specification, ab-
traction, verification, maintenance, performance tuning. Includes substantial programming. P, 237 or E.C.E. 271b; 342.

534.* Advanced Computer Graphics and User Interface (3) I Advanced aspects of computer graphics and interaction; hidden surface elimination algorithms, lighting models, techniques for photo-realism, parametric surfaces, user interface design and evaluation, window systems, user interface management systems. P, 533.

541a-541b. Computer-Aided Information Systems Analysis and Design (3-3) (Identical with M.I.S. 541a-541b)

543.* Theory of Graphs and Networks (3) II (Identical with Math. 543)

545. Design and Analysis of Algorithms (3) II Time, space complexity; recurrences; algorithm design techniques; lower bounds; graph, matrix, set algorithms; sorting; fast Fourier transform; arithmetic complexity; intractable problems. P, 445, Math. 362.


550.* String and List Processing (3) I Data representation, pattern matching, programming techniques; applications. P, 327, 373, 430.

552. Advanced Operating Systems (3) I Operating system design, implementation and modeling; deadlock and memory management models; protection mechanisms; operating systems for parallel and distributed systems. P, 452.


570.* Artificial Intelligence (3) II Theory and practice of artificial intelligence: problem and knowledge representation, searching and heuristics, predicate calculus, mechanical reasoning, production systems, AI languages. P, 327, 373, 430.

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

572a-572b. Continuous-System Simulation (3) I (Identical with E.C.E. 572a-572b)

573. Theory of Computation (3) I Chomsky hierarchy, abstract families of languages, undecidability; general recursive functions; recursion theory; computational complexity theory, NP-complete and provably intractable problems. P, 373. (Identical with Math. 573)

574a-574b.* Computer-Aided Logic Design (3-3) II (Identical with E.C.E. 574a-574b)

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

576.* Computer Architecture (3) I An overview of computer systems from basic components to complete systems. Circuits; CPU, memory, and I/O organization; complete systems from minicomputers to supercomputers. P, 237 or E.C.E. 271b; 342.

578. Computational Methods of Algebra (3) II (Identical with Math. 578)

579.* Game Theory and Mathematical Programming (3) II 1989-92 (Identical with Math. 579)

588.* Computational Linguistics (3) I (Identical with Ling. 588)

*May be convened with 400-level course.

620. Advanced Topics in Programming Languages (1-3) [Rpt./12 units] I Design, implementation, and compilation of programming languages; specific topics to be determined by current literature and faculty and student interest.

630. Advanced Topics in Software Systems (1-3) [Rpt./12 units] I Problems in design and development of large systems of programs; specific topics to be determined by current literature and faculty and student interest.

645. Advanced Topics in Algorithm Analysis (1-3) [Rpt./12 units] II Design and analysis of algorithms; specific topics to be determined by current literature and faculty and student interest.

652. Advanced Topics in Operating Systems (1-3) [Rpt./12 units] II Operating system design, development, analysis, and performance; specific topics to be determined by current literature and faculty and student interest.

673. Real-Time Distributed Processing Systems (1-3) II (Identical with E.C.E. 673)

674. Test Generation for Automata (3) I (Identical with E.C.E. 674)

696. Seminar
a. Current Computing Research (1-3) [Rpt./8] II S

Conducting
(See Music)

Counseling and Guidance
(See Family and Consumer Resources)

Creative Writing
(See English)
East Asian Studies (EAS/CHN/JPN)

Franklin Building, Room 404
(602) 621-5452

Professors Brian E. McKnight, Head, Don C. Bailey (Emeritus), Anoop Chandola, Robert M. Gimello, Earl H. Pritchard (Emeritus), William R. Schultz (Emeritus), Jing-shen Tao

Associate Professors Marie Chan, Charles H. Hedtke, Ronald C. Miao, Chia-ien Pao Tao

Assistant Professors Donald J. Harper, Kimberly A. Jones, Haru Yamada

The Department of East Asian Studies offers programs leading to the Master of Arts and Doctor of Philosophy with majors in East Asian studies. Graduate training in East Asian studies may open doors for careers in teaching, international commerce and banking, government service, and journalism. The department's curriculum in language and special courses on China and Japan affords students important opportunities.

Graduate programs on the master's level are available with concentrations based either in traditional academic disciplines or in specially constructed general study areas related to East Asia. The doctoral programs are rigorously based in traditional academic disciplines. Master's students must complete a minimum of 30 graduate units, including a thesis, or 32 units if a significant departmental paper is substituted for the thesis. Disciplinary concentrations, often in preparation for further Ph.D.-level study, are currently offered in a number of fields in Chinese history and literature; general studies may include broader courses from East Asian Studies and other departments on both Chinese and Japanese areas. The general program is often suitable for preprofessional training; despite its possible breadth, it must display grammatical integrity. Doctoral study must be focused on Chinese history, literature, thought, religion, or international relations; minor fields are usually selected from other supporting disciplines.

Admission requires adequate preparation, although admission with some deficiencies is possible. The department bases admission into the master's and doctoral programs upon the grade-point average (3.5), the applicant's statement of purpose, two letters of recommendation, and GRE scores. Foreign students must achieve a minimum score of 550 in the TOEFL. Applicant objectives must also correspond to East Asian Studies' programmatic capacities. Contact the East Asian Studies' graduate secretary for further details.

East Asian Studies (EAS)

503b. Introduction to Comparative Literature and Literary Theory (3) (Identical with Cp.Lt. 503b)

527a. *The Prehistory of East Asia (3) I (Identical with Anth. 527a)

545. *Hindu Mysticism (3) II Introduction to the major concepts and practices of Hindu mysticism, including yoga techniques, rites, symbols, and myths. (Identical with Reli. 545)

551. *The United States and East Asia: 1840 to the Present (3) II 1992-93 (Identical with Hist. 551)

552. *Hindu Literature (3) I introduces major literary works with ancient Sanskrit genres. Selections from the Vedas, epics, Puranas and other classics in English translation.

563. *Asian Marxism (3) II Comparative historical study of several Marxist revolutionary movements. (Identical with Hist. 563)

564. *International Relations of East Asia (3) I (Identical with Pol. 564)

587a-587b.* History of East Asian Buddhism (3-3) Buddhism in China, Korea and Japan with emphasis on the relationship between East Asian Buddhist thought and practice and the various historical contexts in which they emerged.

589. *Women in East Asia (3) I (Identical with Hist. 589)

502.* Linguistic Structure of Modern Chinese (3) I Linguistic study of the phonological, morphological, and syntactic systems of modern Chinese, with particular attention to linguistic analysis. (Identical with Ling. 519)

520.* Linguistic Structure of Modern Chinese (3) II Linguistic study of the phonological, morphological, and syntactic systems of modern Chinese, with particular attention to linguistic analysis. P. 419. (Identical with Ling. 520)

521. Resources and Methods in Sinology (3) II Introduction to and exercises in the use of standard sinological reference and research resources. P. 523.


523. Literary Chinese (3) II Introduction to pre-20th-century Chinese styles through readings in classical Chinese literature. P. 522.

527b.* The Archaeology of Pre-Han China (3) II (Identical with Anth. 527b)

540.* Chinese Calligraphy (2) [Rpt.] I Theory, practice, and aesthetics of Chinese brush writing, with emphasis on individual training and development.

541. Chinese Historical Linguistics (3) I Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P. 402 and a course in general linguistics.

542. Chinese Historical Linguistics (3) II Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P. 541.


547. Readings in Classical Chinese Prose (3) [Rpt.] I Readings in selected texts from literary, philosophical, and historical traditions; includes selections from the Five Classics and the great prose masters of the Han-Qing. Variable content, P. 523.

550. Studies in Modern Chinese (3) [Rpt.] I S Grammar, conversation, and readings in modern Chinese texts, with emphasis on oral and written comprehension and expression. P. consult department before enrolling.

560.* Modern Chinese Foreign Relations (3) II (Identical with Pol. 560)

568. *Women in China (3) I Analysis of the role of women in Chinese society with equal emphasis on traditional and modern periods.


576. Modern Chinese History (3) Historical survey of the period since 1911 which examines the revolutionary developments shaping contemporary China. (Identical with Hist. 576)

582. Social History of China (3) Formation of ancient Chinese society; organization of families and clans; social stratification, mobility, conflict, and control in traditional China; and transformation from traditional to modern society. (Identical with Hist. 582)
Assistant Professors Judith L. Bronstein, Wayne Maddison, Nancy A. Moran, Daniel R. Papaj, Richard E. Strauss, J. Bruce Walsh

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in ecology and evolutionary biology and in botany. Concentrations are available in ecology, systematics, evolutionary biology, and evolution; evolutionary theory; ecological and molecular genetics; environmental physiology; marine biology; animal behavior; population and community ecology; vertebrate biology and systematics; evolutionary morphology; and theoretical and mathematical biology. The department maintains excellent collections of fishes, amphibians, reptiles, birds, and mammals. An extensive herbarium is shared with the College of Agriculture. Field work is facilitated by a Marine Biology Station at Puerto Penasco, Sonora, Mexico and by the availability of the Coronado Ranch in the Chiricahua Mountains, the Southern Research Station, Portal, Arizona, the Research Ranch, Elgin, Arizona, and the Desert Laboratory on Tumamoc Hill, Tucson, Arizona.

Graduate students are required to furnish the department with completed departmental application forms, copies of scores on the Aptitude and Advanced (any discipline) tests of the Graduate Record Examination, copies of transcripts of all college work, copies of GRE scores (in addition to those required by the Graduate College), and three letters of recommendation from persons qualified to evaluate the applicant's scholarly potential. Applications should be submitted by January 15; admission is normally approved only for the fall semester. Applicants are encouraged to seek external financial support from institutions such as the National Science Foundation and the Danforth Foundation. The department will make every effort to offer financial aid in the form of teaching or research assistantships.

Course work, while necessary, is no substitute for scholarship. Accordingly, particular emphasis is placed on the student's ability to formulate and pursue original research problems. One course, Research in Ecology and Evolution (610a-610b), is required of all new graduate students. The remainder of the program is designed to meet the individual needs of each student.

In addition to the courses listed below, the department offers courses in quantitative genetics, phylogenetic systematics, evolutionary morphology, plant physiological ecology, biological rhythms, and approaches to problem solving in biology.


535.* Evolution (3) I A balanced survey of the present-day concepts of the process and products of evolution, with emphasis on contrasting models and their consequences; recent techniques for the elucidation of phylogenetic pathways. P, 302, 320; Math. 125a, P or CR, 125b. (Identical with Gene. 535)

536.* Plant Ecology (4) II Dynamic processes giving rise to ecological patterns in plant populations and communities. 2R, 6L. Field trips. P, some botany and general ecology.

538.* Biogeography (3) II The role of historical events and ecological processes in determining the past and present geographic distribution of plants and animals. P, 182 or Geos. 225. (Identical with Geos. 538)

540.* Oceanography (2) I 1992-93 Introduction to the physical, chemical, geological, and biological dimensions of the oceans, with emphasis on their importance as biological environments.

540L.* Oceanography Laboratory (2) I 1992-93 Field and lab. investigations of the Gulf of California, with emphasis on research techniques important to biological oceanography. Weekend field trips. P, 540R or CR.

541.* Limnology (4) I (Identical with W.F.Sc. 541)

542.* Marine Ecology (6) S A field introduction to basic concepts in marine ecology with emphasis on the behavior and ecology of invertebrates and fishes and the factors affecting the diversity of the community structure of marine communities. The entire course is conducted at selected sites in the Gulf of California. Consult instructor 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)

545. Concepts in Genetic Analysis (3) I (Identical with M.C.B. 545)


555.* Comparative Vertebrate Anatomy (4) I (Identical with V.Sc. 558)

559.* Comparative Vertebrate Histology (4) II (Identical with V.Sc. 559)

560.* Plant Physiology (4) I (Identical with Pl.S. 560)

566.* Physiology Laboratory (2) II Emphasis on data acquisition, analysis and interpretation. Laboratory techniques and investigation of physiological mechanisms. P, either 437, 468; V.Sc. 400a-400b; or Psio. 480. (Identical with M.C.B. 566, Psio. 566, Tox. 566, V.Sc. 566)

568.* Comparative Physiology (3) II The responses of physiological systems to the environment; energy exchanges, respiration, thermal and osmotic regulation, locomotion, behavioral regulation, and integration of responses. P, 181, 182.

570.* Plant Diversity and Evolution (4) I Survey of the plant kingdom, with emphasis on comparative structure and evolution of major plant divisions. 2R, 6L. Field trips. P, 4 units of biological or plant sciences.

571.* Human Embryology (4) II (Identical with Anat. 571)

572.* Systematic Botany (4) II Evolutionary relationships of orders and families of spermatophytes, systems of classification; collection and identification of local flora. 2R, 6L.

575.* Freshwater Algae (4) I 1991-92 Systems, 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.

578.* Global Change (3) II (Identical with Geos. 578)

579.* Art of Scientific Discovery (3) [Rpt.] II Techniques of posing questions and solving puzzles encountered in scientific research, with emphasis on life sciences and mathematics. P, consult with department before enrolling.

580.* Invertebrate Zoology (4) I Comparative morphology, physiology, and ecology of invertebrates. 3R, 3L. Field trips. P, 182.

582.* Ichthyology (4) I 1991-92 Ecology, evolution and systematics of fishes, with field and lab. emphasis on Gulf of California and Arizona fishes. 2R, 6L. Weekend field trips. P, 182. (Identical with W.F.Sc. 582)

583.* Herpetology (4) II Systematics, ecology, and evolution of the amphibians and reptiles. 2R, 6L or field work. P, 304.

584.* Ornithology (4) II Natural history of birds and its bearing upon the problems of animal behavior, distribution, and evolution. 2R, 2L. Field trips. P, one basic biology course. (Identical with W.F.Sc. 584)

585.* Mammalogy (4) I Systematics, ecology, and evolution of mammals. 2R, 6L or field work. P, 304. (Identical with W.F.Sc. 585)


587.* Animal Behavior (3) I Concepts and principles of the evolution, development, causation and function of behavior, with emphasis on the adaptiveness of behavior; discussion and films. P, 8 units of 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 1992-93 Methods for studying form variation and diversification; size-shape relationships; theoretical morphology.


598. * Selected Topics in Marine Biology (1-4) [Rpt./6 units] II Field trips. P, junior or senior ecology majors.

601. Sociology (2) [Rpt./3] I


*May be convened with 400-level course.

Economics (ECON)

Economics Building, Room 202 (602) 621-6224


Associate Professors David A. Conn, John Z. Drabicki, Price V. Fishback, Donald G. Hecker, James C. McBrearty, David E. PIngrY, Stanley S. Reynolds, Gerald J. Swanson, Ronald J. Vogel (Management and Policy)

Assistant Professors Eskander Alvi, Devayoti Ghose, Shawn Kerner, Kenneth F. Krone, Michael P. Leidy, Barbara N. Sands, Leslie Stratton

The department offers programs leading to the Master of Arts and Doctor of Philosophy degrees with a major in economics. The department also offers supporting work for the Master of Public Administration degree, the Master of Business Administration degree and Doctor of Philosophy degree with a major in management. 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 aptitude test of the Graduate Record Examination.

Degrees

Master of Arts: All students must complete the core program consisting of 501a, 502a, 519, 520, and 522 or 549, and a nine-unit field of specialization. (A minimum of thirty total units is required.) The field of specialization may be in economics or a related area and must be approved by an advisor. The student will be given a comprehensive exam over the core program and field. No thesis is required.
500. Managerial Economics (3) I S Microeconomic theory and applications. P. M.I.S. 400 or Math. 119 or 123. Advanced degree credit available for nonmajors only. Open only to students admitted to a BPA graduate program.


503. Development of Economic Theory (3) II Development of economic thought from ancient times to the present. P. 501a.

504. Production Economics (3) I (Identical with A.E.C. 504)


507*. Studies in Microeconomics (3) II Studies in microeconomics, such as the economics of imperfect information and uncertainty, externalities and public goods, and imperfect competition. P. 501b, Math. 125b.

509*. Economic Anthropology (3) II (Identical with Anth. 509)

510. Microeconomics (3) I Theory of income, employment, interest rates, and the price level. P. 500: Advanced degree credit available for nonmajors only.

511*. Microeconomic Theory and Behavior (3) II Microeconomic theory with an emphasis on the use of experimental laboratory and field methods for testing the behavioral implications of the theory. P. 521.

512. International Agricultural Economic Development (3) II (Identical with A.E.C. 512)

513. Consumption Economics and Price Analysis (3) III (Identical with A.E.C. 513)

514. Cost-Benefit Analysis (3) II (Identical with A.E.C. 514)


516*. Introduction to Econometrics (3) I II Statistical methods in estimating and testing economic models, single and simultaneous equation estimation, identification, forecasting, and problems caused by violating classical regression model assumptions. P. 339 or M.I.S. 375 or M.I.S. 552.

519. Mathematical Economics (3) I Introduction to the theory and methods of mathematical economics and its applications. Designed primarily for entering graduate students majoring in economics. P. CR, 520; consult with department before enrolling.

520. Theory of Quantitative Methods in Economics (3) I Introduction to the basic concepts of statistics and their application to the analysis of economic data. Designed primarily for entering graduate students majoring in economics. P. CR, 521; consult with department before enrolling.

521*. Introduction to Mathematical Economics (3) II Comparative statics, stability, classical optimization, the Kuhn-Tucker theory, calculus of variations, linear algebra, and game theory, and the application of these techniques in economic analysis. P. six upper-division units in economics; Math. 125b.

522. Econometrics (3) I The theory of econometric estimation of single and simultaneous equation models. P. 520.

523. Advanced Economic Modeling (3) II Mathematical methods of formalizing economic concepts, utilizing analysis, topological methods, and dynamic optimization. P. 519.

524*. Topics in European, Chinese, or Japanese Economic History (3) III I Examines the economic history and development of medieval, early modern and modern Europe; the development and economic history of premodern and modern Japan and China. P. 500 and 361.

525*. Topics in the Economic History of the United States (3) III I Examines the economic history and development of the United States, including roles of legal and cultural institutions, changes in output mix, government regulation, income distribution, monetary policy, and demographic factors. P. 500 and 361.

530. Macroeconomic Aspects of Finance (3) III I The effects of changing economic conditions upon a firm's operation, including capital decisions as well as production decisions. P. 500.

534. Public Finance (3) III I The study of public fiscal economics, with emphasis on relevant topics for public administration and urban planning graduate students: public goods, tax and nontax revenues, intergovernmental issues, benefit-cost analysis. P. 500.

536. Innovation and Economic Growth (3) III I (Identical with Mktg. 536)


553. Business and Economic Forecasting (3) I Forecasting techniques used in business and government; assembly, interpretation and use of economic data: analysis of business conditions; examination of related environmental factors; construction of actual sales or revenue forecasts. P. 500; M.I.S. 552.

559*. Agricultural Economic Development in Latin America (3) III I (Identical with A.E.C. 559)

560*. Industrial Organization (3) I Structure, conduct, and performance of American industry: governmental institutions and policies affecting business. P. 300 or 361; 339 or M.I.S. 555.

561*. Economics of Regulated Industries (3) II Analysis of the regulated sector of the American economy, including communications, transportation and energy industries; impact of existing and alternative public policies. P. 300 or 361 or 500.

562. Theory and Institutions in Industrial Organization (3) III I Major issues in the field of industrial organization. Theoretical issues presented with complementary material dealing with specific American industries. P. 500.

568. Environmental Scanning (3) III I (Identical with M.A.P. 568 and Mktg. 568)


575*. Economics of Land and Water in the American West (3) III I (Identical with A.E.C. 575) *May be convened with 400-level course.

576. Advanced Natural Resource Economics (3) III I (Identical with A.E.C. 576)

577. Natural Resource Economics and Public Policy (3) III I (Identical with A.E.C. 577)

597. Workshop

a. Frontier Applications of Economic Theory (3) I P. 501a, 502a, 521, 549.

b. Computational Methods in Laboratory Economics (1-3) [Rpt. 3 units] I II P. Math. 125a-125b; consult department before enrolling.

c. Economic Issues for Teachers (3) S Consult instructor before enrolling.

d. Summer Institute on the American Economy (3) S Consult instructor before enrolling.

e. Economics Education Workshop (2) S Consult instructor before enrolling.

f. Economic Development for Educators (2) S Open to nonmajors only. Consult with department before enrolling.

696. 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 I (3) II

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 I (3) II

u. Game Theory I (3) I

v. Public Choice I (3) II (Identical with Pol. 696v)

w. Public Choice II (3) II (Identical with Pol. 696w)

697. 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. 696h, 696i.
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 degree programs.

500. Disciplined Inquiry in Education (3) I I S Introduction to research methods in education: analysis of research; writing of research review; applying research results in educational settings.

501. Foundations of Education (3) I I S Schools and social institutions; political and social influences on education; nature of the education profession; reform and implementation in education.

502. Variations in Learners (3) I 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.


601. Qualitative Methods in Education (3) I I S Introduction to theory and methods of conducting research through extended participant observation in school or community settings; field work, ethnography, case study, qualitative methods. P, 500.

602. Research Design and Techniques in Education (3) I I S In-depth exploration of various research paradigms in educational inquiry and their research designs; critical analysis of the structure and logic of various designs and techniques; preparation of research proposals. P, 600, 601.

604. Leadership for Educational Change (3) I I S Investigations of the characteristics of leadership as they apply to changing basic educational organizational structures and processes.

605. Evaluation of Educational Programs and Personnel (3) I I S Models, purposes served, contextual influences and procedures employed in evaluating educational programs and personnel. P, 500.

606. Policy Analysis in Education (3) I I S Understanding of and necessary skills to provide leadership in the area of educational policy development and analysis.

611. Comparative Education (3) I I S 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) I I S Analysis of values and conflicts in American culture as they affect educational policy; critical examination of contending philosophies in the light of democratic ideals.

613. History of Western Education (3) I I The historical development of western educational thought from its origins to the present.

614. History of Education in the United States (3) I I The development of American educational thought from its colonial origin to the present.

615. Educational Sociology (3) I I S 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/EPP/HED)


Associate Professors Harley D. Christiansen (Emeritus), Sharon C. Conley, Sarah M. Dinham, Joseph D. Guilio (Emeritus), Marcello Medina, Stanley Fogrow, Gary Rhoades, Donal M. Sacken

Assistant Professors Paul E. Heckman, Valerie R. Reyna

The division offers programs leading to the Master of Arts degree with majors in educational psychology, foundations of education, and higher education. The Educational Specialist degree is offered with majors in educational administration and educational psychology. The Doctor of Education degree is offered with a major in educational administration. The Doctor of Philosophy degree is offered with a major in 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, master's degree programs may be designed to meet the requirements for the Arizona Community College Teaching Certificate (Type I) or for entry-level administrative service in institutions of higher education.

An undergraduate grade-point average of at least 3.00 is required for admission to a graduate degree program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

*At the time of catalog production, the Master of Arts and Doctor of Philosophy degree programs with a major in foundations of education were under review. Consult the division or the college regarding the status of these programs.

Educational Administration (EDA)

Education Building, Room 635

(602) 621-3327

660. Administration and the Educational Environment (3) I I S Introduction to education...
ational administration; overview of administration within school contexts and larger societal environment; organizational and leadership theories.

661. Administration of Bilingual Education Programs (3) I S Dynamics of the administration of educational programs for the bilingual learner including socio-political realities, mandated federal and state funded educational programs, and effective community participation.

662. Educational Law: Policy and Practice (3) I S Evolution of modern educational law and the effects of law on educational policy formation and administrative practice.

663. Computer Applications in School Administration (3) I Techniques for using computers to make school administration more efficient; using computers to enhance the management of information. P, 660 or CR.


665. Supervision of the Instructional Program (3) II S Purposes of instructional supervision; organization, techniques and skills for supervisory competency. P, 660.

666. Educational Governance and Collective Bargaining (3) II Theory and practice of collective bargaining; history of negotiations in the educational sector; impact of statutes and governing authority. P, 660, 662 or CR.

668. Managing 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, 660 or CR.

670. School Finance (3) I Historical background of the financing of education in the United States; economics and principles; sources and distribution of funds for education; budgeting, accounting, and reports. P, 660, 661 or CR.

672. School Business Management (3) II The general management of school business; administration and accounting of school funds; administration of equipment and supplies; other business operations. P, 660 or CR.

674. Law and Administrative Practice (3) II Routine and continuous effects of law in public schools; tort liabilities; collective bargaining; influence of federal and state regulations, teacher dismissal; Arizona statutory and case law emphasized. P, 660, 661, 662.

675. Theory and Behavior in School Organizations (3) I II Perspectives on the nature of the individual in the school organization; nature of schools as organizations; development of individual-organizational relationships. P, 660.

681. The Principalship (3) I II Functions and activities of building-level administrators, with emphasis on instruction, staff development, student services evaluation, and operational services. P, 693a and 15 units of educational administration, CR, 693b.

682. The Superintendency (3) I II Functions and responsibilities of the chief school executive and central office staff, with emphasis on external and internal system relationships in policy formation and decision-making. P, 693a, 693b or CR.

693. Internship a. Educational Administration (2-3) [Rpt./4 units] II S P, 660, 661, 662 or CR.
b. Advanced Educational Administration (3-4) [Rpt./8 units] II S P, 693a and 15 units of educational administration. CR, 681 or 682.

694. Practicum a. Educational Administration (1-3) [Rpt./12 units] II

695. Colloquium a. Issues in Educational Administration (1-3) [Rpt./12 units] II

696. Seminar a. Topics in Educational Administration (1-3) [Rpt./12 units] II

697. Workshop a. Problems in Educational Administration (1-3) [Rpt./12 units] II

Educational Psychology (EDP)

Educational Building, Room 602 (602) 621-7825

500. Life Span Development (3) II Dynamics of development, social integration and roles across the life span. Special emphasis on cognitive, emotional, and personality development with concentration on the antecedent events to adult life experiences. (Identical with F.S. 500)

501. Advanced Child Development (3) II Aspects of growth and development which influence behavior of the school-age child; emphasis on current research findings. P, 301.

502*. Early Adolescent Development (3) II S Major cognitive, psychosocial, physical and anthropological developmental theory of early adolescence (ages 10-14 years old). Also, the implications of theory into practice regarding early adolescents and schooling.

503. Advanced Adolescent Development (3) II Major developmental issues within the adolescent years; emphasis on the importance and design of adolescent research. (Identical with F.S. 503)

504. Advanced Adolescent Development (3) II Major developmental issues within the adolescent years; emphasis on the importance and design of adolescent research. (Identical with F.S. 503)

505. Advanced Adolescent Development (3) II Major developmental issues within the adolescent years; emphasis on the importance and design of adolescent research. (Identical with F.S. 503)

506. Learning Theory in Education (3) II Major theories of learning and motivation; emphasis on relationships between theory and practice in the schools.

517. Classroom Application of Behavior Modification Techniques (3) II Application of behavior principles and techniques to promote learning and social development of school-related behavior. 2R, 3L, P, 510 or CR.

530. School Psychology (3) I II Roles of the school psychologist; implementing programs in the public schools; legal and ethical issues in school psychology. 2R, 3L.

541. Statistical Methods in Education (3) I II Descriptive, correlational, and inferential procedures for presenting and analyzing school and research data. For students in all fields.

557. Design of Questionnaires and Scales (3) I II Emphasis on theoretical and methodological issues related to the development of survey and rating scales, sampling procedures, and response bias.

558. Educational Tests and Measurements (3) I II Theoretical and practical application of psychometric techniques to test construction, analysis, and interpretation of test results. P, 541.

559. Testing of Minorities (3) II Current theoretical, social, and practical issues in the use of norm-referenced tests with individuals from minority cultures.

600. Theories of Human Development (3) I History and analysis of psychological theories of human development and a comprehensive overview of major theoretical systems. P, 500 or 501.

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

615a-615b. Cognitive Development (3-3) II Cognitive theory and research as they bear upon educational and educational processes. P, 500 or 501.

619. Design of Instruction (3) II Historical and theoretical bases for developing instructional design; emphasis on relationship between learning theory and instructional design. P, 510.

638. Behavioral Consultation in Educational Settings (3) I II Principles and techniques of conducting behavioral consultation in educational settings to promote learning and development of children and youth. 2R, 3L. P, 517.

640. Advanced Statistical Methods in Education (3) I II Inferential procedures for analyzing educational data; includes nonparametric methods and introduction to multivariate and causal procedures. P, 541.

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


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

673. Theories of Intellectual Assessment (3) I II Various theories and models of human ability and their implications for intellectual assessment. P, 558 or CR.

674a-674b. Field Experience in Intellectual Assessment in Education (3-3) II Supervised field experience in the administration, scoring and interpretation of various intellectual assessment devices. 674a: Wechsler Adult Intelligence Scale. 674b: Intellectual assessment techniques. 1R, 3L. Open to majors and minors
only. Credit allowed for 674a or 674b, but not for both. P. 673 or CR.

677. Individual Assessment Techniques in the Schools (3) II Techniques for assessing personality and social behavior; practice in implementing programs derived from assessment techniques. 2R, 3L. Open to majors and minors only. P. 674a.

679. Psychoeducational Assessment in the Schools (3) I Psychoeducational assessment techniques; practice in prescribing remedial programs. 2R, 3L. Open to majors and minors only. P. 673, 674b.

682. Educational Program Evaluation Principles and Techniques (1-3) [Rpt./1] Development and current viewpoints, political context, illustrative cases, technical skills for determining merit or making decisions about educational and social programs. P. 541, 558.

685. Child Behavior Disorders and Adjustment (3) I II The diagnostic and assessment practices, theories, and research related to child behavior disorders. P. 530.


693. Internship b. School Psychology (1-4) [Rpt./12 units] I II S

694. Practicum b. School Psychology (1-3) [Rpt./12 units] III

695. Colloquium b. Issues in Educational Psychology (1-3) [Rpt./12 units] I II

696. Seminar b. Issues in Educational Psychology (1-3) [Rpt./12 units] I II

Higher Education (HED)

Education Building, Room 327 (602) 621-7951

561. The Community College (3) I The scope, objectives, and educational functions of the community college, patterns of community college programs.

601. Higher Education in the United States (3) I The scope of higher education in the United States; brief survey of historical developments and philosophic bases, public policy issues at the state and federal level; types of institutions and their purposes; characteristics of faculty, students and curricula.

608. The College Student (3) I History and characteristics of the college student; interactions with campus environmental influences; developmental and normative trends; major research findings.

609. Organization and Administration in Higher Education (3) I Organizational theory, structures, systems, and administrative procedures in varied higher education institutions; patterns of governance and policy development.

617. Student Personnel Services in Higher Education (3) I Student personnel services, purposes, procedures, representative programs, current trends.

622. Teaching in Higher Education (3) II Planning, organizing, and evaluating learning experiences for mature students.

641. Institutional Research and Planning (3) I Development of institutional research programs for short-term and long-term planning; input and output measures.

650. Higher Education Finance (3) I Historical patterns of financing private and public higher education; current sources and types of financial support; alternative methods of financing; social benefits and consumer theories. Field trips.

651. Higher Education Business Management (3) I II Budget planning and execution; systems of resource allocation; personnel management; physical plant planning and construction; information systems and use in management.

661. Higher Education and the Law (3) I II Critical court decisions, past and present, affecting higher education; increasing role of the courts in decision making and policy development. Field trips. P. 601, 609, 621 or 650.

693. Internship c. Higher Education (1-3) [Rpt./12 units] I II

695. Colloquium c. Issues in Higher Education (1-3) [Rpt./12 units] I II

696. Seminar c. Topics in Higher Education (1-3) [Rpt./12 units] I II

Language, Reading and Culture (LRC)

Educational Building, Room 517 (602) 621-1311

Professors Patricia L. Anders, Kenneth G. Goodman, Yetta M. Goodman, Amelia Melnik (Emerita), Kenneth J. Smith, William J. Vaimont
Associate Professors Judy N. Mitchell, Division Coordinator, Adela A. Allen, John M. Bradley, Margaret B. Fleming, Luis C. Moll, James R. Rankin, Richard Ruiz
Assistant Professors Arminda Fuentevilla, Teresa McCarry, Kathleen Short

The division offers programs leading to the Master of Education degree with majors in bilingual/multicultural education. The division also offers programs leading to the Master of Arts degree with a major in educational psychology, and Doctor of Philosophy degrees with a major in language, reading and culture.

An undergraduate grade-point average of at least 2.00 is required for admission to full standing in a graduate degree program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

*At the time of catalog production, the Master of Education degree with a major in reading was under review. Consult the division or college regarding the status of this program.

504. Language and Culture in Education (3) I II Introduction to aspects of language and culture that affect education, particularly in reading, writing and the language arts; discussion of social and political concerns.

505. Essentials of Reading and Writing (3) I II Survey of reading and writing relationships; development, instruction, and evaluation.

507. Teaching of Reading; Decoding and Comprehension (3) I II Linguistic, psychological and cultural bases of decoding and comprehension; theories that influence practice; materials and practices that facilitate learning to read.

508. Bilingual Reading and Writing (3) I Analysis of reading and writing situations encountered by bilingual students; phonological, semantic and syntactic aspects of instruction; methods and materials. P. 505 or CR.

520. * Educating the Culturally Diverse (3) I II Issues faced in education associated with ethnic and linguistic pluralism in the United States; analysis of the interaction of school, community, cultural and family factors in the education of diverse populations.

524. * Methods and Materials in Bilingual Education (3) I II Analysis and evaluation of methods and materials used in bilingual education programs; effective strategies in first and second languages; concurrent and separate language approaches and cooperative models. P. 504.

525. Educating the Bilingual Learner (3) I II Socio-cultural factors, language practices and education; analysis of theories and practices affecting bilingual learners; historical, social, and cultural influences; relationship of theory to the characteristics and needs of the bilingual learner.

527. Developing Language Arts Curriculum (3) I II Curriculum theory and models; staff development for implementing change; scopes and sequence; planning effective learning experiences. P. 504 and 505.

530. * Computer Application for Teachers (3) I II Microcomputer operation; computer-assisted instruction; software evaluation; use of author systems and word processors in the classroom; computer managed instruction; organization for computer use; communications networking; computer networking.

532. Pre-Reading and Beginning Reading Development (3) I II An examination of various aspects involved in pre-reading and beginning reading development, including psychological, sociological, physiological and educational considerations.

535. * Secondary School Reading in the Classroom (3) I II Provisions and procedures for evaluating and developing reading skills needed in content areas.

536. * Classroom Communications and Interaction (3) I II The teacher's role in promoting effective communication and interaction in the classrooms; analysis of both verbal and nonverbal uses of language.

537. Classroom Diagnosis and Instruction (3) I II Procedures for diagnosing and developing reading and writing skills for pupils of below-average achievement level. P. 505, 507 or CR.
551. Reading, Writing and Texts: A Psycho-Sociolinguistic Perspective (3) I II Readers and writers as users of language; reading and writing as language processes; what makes a text a text.

553. Language Acquisition and Development (3) I Study of the development of language in young children; focus on oral language and its relationship to emergent literacy; instructional strategies that build on language development.

554. Applied Linguistics in Education (3) I The application to curriculum, teaching and learning of concepts from linguistics, psycholinguistics and sociolinguistics. P, 551 or CR.

557. Application of Miscue Analysis (3) II Study of miscue analysis to explore the reading process, reading research, and readability, as well as to evaluate readers; applications to reading strategies and curriculum; focus on comprehension. P, 551 or CR.

570. 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, 507 or 551.

578. Field Experience (3) I II Supervised experience in assessment and instruction of literacy-related practices. P, 504, 505 or CR.

580.* Children's Literature in the Classroom (3) I II Analysis of classic and contemporary children's literature of all genres, and its relationship to language, reading and culture.

581. Multicultural Literature and Literacy (3) I II Multicultural literature that fosters self-concept, acceptance, and a sense of identity to develop literacy. Includes readings from the major categories of multicultural literature about Black, Native, Hispanic, and Asian Americans.

595. Colloquium a. Issues in Language, Reading and Culture (3) I II P 504, 505. b. Language, Learning, and Reading Disabilities (3) II (Identical with S.E.R. 595b) c. Issues in Educating Mexican American Children (3) I S P 504, 505. d. Applications of Language and Literacy (3) [Rpt./9 units] II S

597. Workshop a. Southern Arizona Writing Project (3-9) [Rpt./12 units] II S [Identical with Engl. 597a] b. Miscue Analysis in Teacher Education (2-3) II c. Teaching of English (3) I II S (Identical with Engl. 597c, which is home)

612. Grammatical Analysis (3) I (Identical with Engl. 612)

613. Second Language Acquisition in Formal Contexts (3) I (Identical with Engl. 613)

627. Curriculum Development and Supervision in Language Arts (3) I II Organizational patterns of language arts curricula; approaches to improvement of language arts instruction; personnel relations. Designed for the language arts supervisor and school administrator. P 527.

634. Reading Comprehension: Theories, Research and Methods (3) I II Factors affecting cognitive development methods of influencing growth in reading comprehension; examination and analysis of instructional materials; research related to comprehension and cognitive development. P, 507.

635. Reading and Writing in Content Areas (3) 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] II Supervised practice in reading assessment; identification of factors influencing reading achievement, evaluation, construction, and administration of assessment procedures; development of interview techniques. P, 507, 537.

639. Reading Instructional Laboratory (3-6) [Rpt./6 units] II Supervised practice in teaching reading and writing; preparing analyzing and critiquing special instructional programs for students. Open to majors only. P, 507, 537.

653. Written Language Development (3) I II Study of latest research in the writing and reading development of preschool and school-aged children; relationships between reading and writing development explored through student research; applications to instruction. P, 505, 553.

694. Practicum a. Bilingual Education (3) [Rpt./2] P, 15 graduate units including 508 and 525.

696. Seminar a. Language, Reading and Culture (1-3) [Rpt./3] P, 15 graduate units including 504, 505. b. Research in Bilingual Education (1-6) I II c. Research in Language and Literacy (1-6) [Rpt./9 units] II S

795. Colloquium a. Theory and Research in Language, Reading and Culture (1-3) [Rpt./15 units] II P 570.

796. Seminar a. Research and Evaluation in Language, Reading and Culture (1-3) [Rpt./15 units] II P 570.

Special Education and Rehabilitation (SER)

Education Building, Room 412
(602) 621-7822

Professors William C. Healey, Division Coordinator, Sidney W. Bijou, James C. Chalfant, Bob G. Johnson (Emeritus), Jeanne McRae McCarthy, Amos P. Sales, Inez Tucker (Emeritus)

Associate Professors Shirin D. Antia, Candace S. Bos, Daniel Head, Marilyn Jensen, C. June Maker, S. Mae Smith, John Umbreit Assistant Professors Nancy Eldredge, James Organist, Samuel Supalia, Anthony K. Van Reusen

The division offers programs leading to the Master of Arts, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with a major in special education and rehabilitation. The division also offers programs leading to the Master of Education degree with a major in special education.* Concentrations are available within graduate majors offered in the division. Concentrations in special education are behaviorally disordered, hearing impaired, early childhood handicapped, learning disabilities, mental retardation, multiply and severely handicapped, gifted, visually handicapped, and special education administration. Concentrations in rehabilitation are general rehabilitation counseling, rehabilitation psychology, counseling the deaf, counseling the substance abuser, vocational evaluation, and rehabilitation administration.

An undergraduate grade-point average of at least 3.00 is required for admission to full standing in a graduate degree program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

*At the time of catalog production, the Master of Education degree with a major in special education was under review. Consult the division or college regarding the status of this degree program.

500.* Foundations of Special Education and Rehabilitation (3) I II General characteristics of exceptional/disabled persons in interrelated human service delivery systems.

501. Diagnosis and Remediation of Learning Problems (3) I II Procedures, methods, strategies for informal diagnosis 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. P, 400 or CR. Not open to students in the learning disabilities concentration.

502.* Behavior Principles for the Handicapped (3) I II Use of behavior principles to modify the behavior of handicapped persons, especially moderately and severely handicapped. 3R, 1L. P, 400.

503.* The Special Services in the Schools (3) I II Information to aid teachers in dealing with responsibilities and concerns in school settings with regard to P.L. 94-142. Education for All Handicapped Children Act Section 504 of the Rehabilitation Act, Family Education Rights and Privacy Act, and other legal issues.

504.* Cultural and Linguistic Diversity in Exceptional Learners (3) I Provides a theoretical base and practical approach to the study of special needs of students with language and cultural differences; basic premises of bilingual special education and the interface of the two fields.

505.* Introduction to Learning Disabilities (3) I II Theories and history of programs for the learning-disabled—definition, characteristics, etiology. Degree candidates must complete 500 prior to taking 505.

507a-507b. Methods for Diagnosing Specific Learning Disabilities (3-3) | Educational and psychological assessment of academic areas and learning processes involving perception, integration, and expression skills, with emphasis on informal and formal assessment and diagnostic teaching. P, CR, 405/505 or division permission; 593.

508. Teaching Learning Disabled Elementary Students (3) | Remediation of academic areas and cognitive processes involving perception, integration, and expression, with emphasis on strategies for planning and implementing programs at the elementary level. P 405/505, 507a-507b and permission of division; CR, 593, 594.

510.* Introduction to Mental Retardation and Severe Disabilities (3) | History and philosophy of educational programs for persons with mental retardation and other developmental disabilities; etiology, classification, and characteristics, with consideration of educational, social, and psychological problems. P, 400 or CR.


513. Educating Students with Mental Retardation and Severe Disabilities (3) | Methods of developing age-appropriate and functional programming, integration, community-based instruction, and integrative source delivery for students who have moderate to profound retardation and other physical, sensory, and behavior disorders.

515.* Managing Physical Handicaps (3) | Physical and multiple impairments, etiology, intervention practices, adaptations needed, transferring and handling skills, and integration into typical environments. Field trips.

518. Nonoral Communication (3) | Techniques for assessment and intervention of alternative communication skills other than speech for students with severe disabilities. Preverbal communication skills development for all ages; social interaction skills; augmentative communication aids.

520. Low Vision and Visual Functioning (3) | Anatomy and physiology of the eye; implications of visual disorders including visual field losses; introduction to optics; use of optical and nonoptical aids in classroom settings; clinical and functional low vision assessments, including assessing children with multiple impairments; and report writing.

521.* Introduction to Visual Impairments and Deaf-Blindness (3) | An overview of educational services for the student with visual impairments and multiple sensory impairments. An emphasis is placed on the psychosocial effects of visual impairments on the individual and means of compensating for those effects.

522. Orientation and Mobility of the Visually Handicapped (3) | Methods of teaching orientation and mobility skills to visually impaired and blind students. Emphasis on the school-aged child, with particular attention to concept development, orientation skills, pre-cane skills, personal safety, and independent ambulation, including an introduction to long-cane techniques.


524. Methods of Teaching the Visually Handicapped (3) | Curriculum development and adaptation in various educational programs; adaptation of classroom materials and procedures for use with blind and partially sighted children and youth; emphasis on methods of teaching academic and non-academic skills and on educating students with nonhandicapped peers. P, 521; CR, 593.

525.* Strategies of Vocational Development and Supported Employment (3) | Systematic study of the strategies used to place and retain individuals with disabilities in paid, community employment. Topics to include job development, consumer assessment, job placement, job-site training, and follow-up. P, 400.

530.* Education and Rehabilitation of Hearing Impaired Individuals (3) | Current and historical perspectives; educational and rehabilitative services; etiology; impact on families, psychosocial, cognitive and intellectual development, and functioning of hearing impaired individuals.

531a-531b.* American Sign Language (4-4) | Designed to develop intermediate ASL conversational skills in a variety of settings, topics, and functions. P, 370b or division permission.


533.* Interpreting in Special Settings (3) | Classes will be offered on a rotating basis and cover various topics related to interpreting. Field trips.

534. Language Development for the Exceptional Child (3) | Pragmatic, semantic and syntactic aspects of language development in exceptional children and youth; cognitive and social bases for intervention.

535. Assessment of Bilingual Exceptional Learners (2) | Educational and psychological assessment of bilingual students with emphasis on informal and formal evaluation methods and procedures for purposes of identification and educational planning. P, 507.

536. Teaching Bilingual Exceptional Learners (2) | Instructional interventions and program development for exceptional students from culturally and linguistically diverse backgrounds. Emphasis on current intervention methods and practices. P, 508.

537. Language and Reading Intervention for Hearing Impaired (3) | Receptive and expressive language assessment; techniques of teaching language intervention and remediation for hearing impaired children and youth. P, 534; CR, 594b.


539.* History of Deafness (3) | Study of history and culture of deaf people, history of sign language, the evolution of various sign systems, fingerspelling and non-verbal communication aspects of sign language. P, 431b or permission of division.

540.* Education of Gifted Children (3) | Issues in education of the gifted; discussion of definitions, characteristics, development, screening, identification, curriculum, teaching strategies, and program development. P, 400.

541. Teaching the Gifted: Questioning Strategies (3) | Mastery of skills involved in developing abstract thinking abilities in gifted children by using the Hilda Taba Teaching Strategies. Emphasis on using these sequential questioning methods in all content areas and at all grade levels. P, 440/540.

542. Teaching the Gifted: Productive Thinking Models (3) | Mastery of skills involved in developing productive thinking abilities in gifted children by using teaching-learning models developed by Bloom, Renzulli, and Treffinger at all grade levels and in all content areas. P, 440/540.

543. Teaching the Gifted: Hierarchical Models (3) | 1990-91 Introduction to general principles involved in providing a curriculum for the gifted. Overview of ten teaching-learning models commonly used with the gifted. Mastery of skills involved in using the hierarchical models with gifted students. P, 440/540.

550.* Introduction to Behavior Disorders (3) | Issues in education of the behavior disorders; discussion of history, current issues, definitions, characteristics, and theoretical perspectives. P, 400.

551. Teaching Children with Behavioral Disorders (3) | Assessment techniques, academic and behavioral intervention strategies, and classroom management with behavior disordered children and youth.

555.* Rehabilitation of the Aged (3) | Emphasis on aging from the viewpoint of the aging person and those working with the aged.

560.* Introduction to Early Childhood Education for the Handicapped (3) | Focuses on the handicapping conditions impacting on preschool children, programs available to serve them and critical issues in this rapidly evolving field. P, 400.

561. Methods of Teaching Preschool Handicapped Children (3) | Introduction to Early Childhood Education for the Handicapped (3) | Focuses on the handicapping conditions impacting on preschool children, programs available to serve them and critical issues in this rapidly evolving field. P, 400.

562. Methods of Assessment for Preschool Handicapped Children (3) | Norm-referenced and criterion-referenced instruments for screening, diagnosis and assessment of preschool children will be reviewed. Emphasis will be placed on teacher involvement in the assessment process. P, 400/500.
Client Assessment in Rehabilitation (3) II Exploration of the world of work; critical review of vocational choice theories; experiences in the use and interpretation of individual assessment techniques. P. 565 or CR; Ed.P. 458.

Principles of Rehabilitation (3) Principles underlying rehabilitation programs and interdisciplinary relationships of agencies engaged in rehabilitation services.

Administration of Special Education Programs (3) II Practical aspects of organization and development of special education programs; problems of public relations, personnel, case finding, evaluation, placement, and records. P. consult division before enrolling.

Supervision of Special Education (3) I Practical aspects of supervising special education programs and services; curriculum development, service delivery models, staff development, program development, and legal issues and requirements.

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.

Observation and Participation in Special Education Programs (1-3) [Rpt./6 units] II Specific types of exceptional individual, psychological and educational implications and practices. Field trips, class observations and seminars. P. 400/500.

Prevention of Addictions (3) I Analysis of addictive behaviors (e.g., drug addictions, eating disorders, compulsive gambling) from a psychosocial and biological perspective and the implications of this analysis for primary, secondary, and tertiary prevention of addictions.

Medical Aspects of Disability (3) I Etiology, therapy, and prognosis of the major disabilities, including drug and alcohol; assessment of physical capacities and limitations; typical restorative techniques.

Psychosocial Aspects of Disability (3) I Exploration of the psychological and sociological aspects of disability; analysis of somatopsychology, psychosomatics, and social psychology.

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.

Counseling Practices in Rehabilitation Setting (3) I II Facilitation training of rehabilitation professionals in their implementation of counseling practices with varied ethnic, age, disability, and dependency populations. 3R, 1L. Open to majors only.

Problems of Drug Abuse (3) [Rpt./1] I II Survey course for teachers, counselors, and agency workers concerned with drug abuse; examination of community, cultural, and educational approaches to drug use and abuse.

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.

Psychosocial Assessment of the Deaf Person (3) II Selection, administration, and interpretation of various psychosocial evaluation instruments used with deaf persons. P. Ed.P. 673, 674a.

Construction and Development of Assessment Samples (3) II Use of occupational information, career exploration and job analysis techniques; development, construction, standardization, and use of work samples and related vocational assessment techniques. P. 565, 582, 563.

Professional Problems in Rehabilitation Psychology (3) I Course will discuss professional problems such as research, publishing, membership in professional organizations, including participation and presentation, legislation, monitoring the profession and defining new professional issues. P. 565.

Counseling and Case Practices with the Deaf (3) II Principles, methods, and techniques of counseling and case practices with deaf people in rehabilitation settings. P. 583.

Applied Research with 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.

Internship (1-12) I II Special sections in each concentration to be arranged in the division office.

Practicum
a. Communication Development for Hearing Impaired Children (1-6) I II
b. Teaching the Gifted (1-6) [Rpt./9 units] II S CR 440, 541, 542, 543.

Colloquium
a." Substance Abuse Education (1) II
b. Language Learning and Reading Disabilities (3) II (Identical with L.R.C. 595b)
c. Mental Retardation and Severe Disabilities (3) II P. 400

Recent Advances in Special Education and Rehabilitation (3-6) I II
e. Bilingual Special Education (2) II
f. Behavioral Disorders (3) I Open to majors only.
g. Group Processes (3) I II

May be converted with 400-level course.

Workshop
a. Creativity and Giftedness (3) [Rpt./9 units]

Colloquium
a. Issues and Trends in Special Education (3) II
b. Behavior Disorders (3) II
c. Rehabilitation Psychology (3) [Rpt./9 units] II
d. Learning Disabilities (3) I
f. Sensory Impaired (3) II
g. Issues and Research in Educating the Gifted (3) [Rpt./9 units]
h. Rehabilitation Administration (3) I I
j. Rehabilitation of the Deaf (3) II
l. Diagnosis in Rehabilitation Psychology (3) II

Teaching and Teacher Education (TTE) Education Building, Room 735 (602) 621-1602


Associate Professors Ruth A. Beeker, Evelyn M. Carswell (Emerita), Kathy J. Carter, Vivian E. Cox, Vivian F. Dutton (Emerita), Willis D. Horak, Cath F. Largada, Glenn S. Pate, Alice S. Paul, D. Paul Robinson, Janice L. Streitmatter, Violet S. Thomas (Emerita)

Assistant Professor Virginia W. Horak

The division offers programs leading to the Master of Arts, the Doctor of Education, and Doctor of Philosophy degrees with a major in teaching and teacher education; the Master of Education degree with a variety of majors relevant to secondary school teaching; the Master of Education and Educational Specialist degrees with a major in educational media; the Master of Education and Master of Teaching with majors in elementary education and in secondary education*. For information concerning these programs, see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

An undergraduate grade-point average of at least 3.00 is required for admission to full standing in a graduate program. However, applicants with undergraduate grade-point averages of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (in education or a related discipline) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

*At the time of catalog production, the Master of Education and the Master of Teaching degrees with majors in elementary education and secondary education, and the Master of Education and Educational Specialist degrees with a major in educational media were under review. Consult the division or college regarding the status of these degree programs.

Teaching of Modern Languages (3) I Specific methods, objectives, organization of subject matter and evaluation in modern languages. (Identical with Fre. 514 and Span. 514)

Observation and Supervision of Student and Inservice Teachers (3) I II S Research-based strategies to supervise and critique teaching events, and to determine positive ways of thinking and acting in classrooms.

The School Curriculum: Science (3) I II S Elementary and secondary science curricula
in terms of their aims content/processes, instructional methods and assessment. These science curricula are placed within a historical perspective and are examined from a theoretical and research base, P. 324 or 338.

521. The School Curriculum: Mathematics (3) I II S Elementary and secondary mathematics curricula in terms of their aims content/processes, instructional methods and assessment. These curricula are placed within a historical perspective and are examined from a theoretical and research base, P. 326 or 338y.

522. The School Curriculum: Social Studies (3) I II S Elementary and secondary social studies curricula in terms of their aims content/processes, instructional methods and assessment. These social studies curricula are placed within a historical perspective and are examined from a theoretical and research base, P. 327 or 338y.


526. Investigations in Early Childhood Education (3) I II S Critical study and evaluation of research findings and learning theories with emphasis upon pedagogical implications related to early childhood education.

528. Developing Programs for Young Children (3) I II S Contemporary early educational programs with an emphasis upon the child's changing needs in the home, school and society. Criteria unique to particular ECE programs are analyzed to establish guidelines for program development.

529. Classroom Organization and Management (3) I II S An analysis of concepts, research findings, and effective practices for organizing and managing classrooms. Experiences in solving management problems provided. P. 539 or CR, and Educ. 500.

532. Mathematics Diagnosis and Remediation (3) I II S The nature and causes of students' difficulties in mathematics, diagnostic techniques, and the development of prescriptive principles of remedial instruction in mathematics, P. 326.

536. Alternatives in the Secondary Classroom (3) I II S Theoretical bases, methods and strategies for delivering instruction in secondary classrooms are examined, discussed and applied.

537. Equality in Schools and Society (3) I II S Implicit and explicit ways in which values are introduced into the classroom and school. Research on the hidden curriculum, ethnic/racial and sex equity and prejudice and methods for combating inequities.

539. Recent Research on Teaching and Schooling (3) I II S An overview of the concepts, methodologies and findings of recent research on teaching and schooling practices.

542. The Middle School/Junior High (3) I II S History, purposes, curriculum, instructional organization, and classroom processes for middle schools/junior high schools.

545. Curriculum Theory and Policy (3) I II S A survey of theoretical frameworks in curriculum; the processes of content representation and enactment; planning evaluation, and change; analysis of curriculum policy.

597. Workshop
v. Middle Level School Development (3) S

610. Applied Curriculum Theory (3) I II S The theories, techniques, and organization of curriculum construction are discussed, evaluated, and applied.

612. Staff Development (3) I II S The concept, context, content, processes and evaluation models of staff development as enacted in school settings, P. Educ. 500.


635. Policy Analysis in Teaching and Teacher Education (3) I II S Examination of policy development and enactment related to teaching and teacher education at local, state, and national levels, as well as methods and approaches to policy analysis. P. 539 and Educ. 500.

644. Teacher/Student Cognition and Instruction (3) I II S An examination of cognitive models related to teacher comprehension, planning, and decision making; and to students' cognitive change and their interpretation of classroom events. P. 539 and 696b; and Educ. 500.

642. Middle-Level Curricular Process (3) I II S Examination of procedures for curriculum/ instructional development, implementation, improvement, and evaluation at the middle-school level. P. 542.

696. Seminar

b. Research on Teaching (3) I II S P. 539, 545 and Educ. 500.

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Educational Administration
(See Education)

Educational Foundations and Administration
(See Education)
The Ph.D. program must contain a minimum of 54 units of course work (including the Master of Science degree) and 18 units of dissertation study. A minimum of 18 units in the major field and 6 to 12 units in the minor field must be completed at the University of Arizona. To satisfy the residence requirement, the student must spend a minimum of two regular semesters of full-time study on campus. Students must pass a qualifying examination, which is taken during the first semester of residence beyond the master's degree, and are admitted to candidacy after passing a written and oral preliminary examination near the end of the study program. The final examination is a defense of the dissertation. There is no foreign language requirement.

Applicants are required to submit Graduate Record Examination (GRE) General Test scores and a statement of purpose directly to the department. All students whose native language is other than English must submit TOEFL scores directly to the Graduate College. Applications to the Ph.D. program must also contain three letters of recommendation from M.S. professors.

Additional details concerning requirements for the master’s or doctoral program may be obtained on request from the department graduate studies office (602) 621-6195.

501. **Linear Systems Theory** (3) I Mathematical descriptions of linear systems, state-variable models, analysis methods-stability, controllability and observability, state feedback techniques, design of feedback controllers and observers.


515. **Instrumentation and Measurement** (3) I Basic concepts of instrumentation and measurement; principles of transducers, operational amplifiers and instrument systems, with emphasis on biomedical applications; lab, experiments with transducers, amplifiers, computers, and medical equipment. 2R, 3L.

517. **Clinical Engineering** (3) I II Activities and responsibilities of clinical engineers; hospital facilities, medical equipment specifications and control, safety, management and health care. P. 508 or 531. (Identical with A.M.E. 517)


523. **Network Synthesis** (3) I Synthesis of passive low-, high-, and band-pass network functions, time and frequency domain approximation, use of optimization techniques.

524. **Active RC Filters** (3) II Modern techniques for realizing active RC filters using passive elements and operational amplifiers gain blocks; determination of sensitivity; effects of gain-bandwidth.

525. **Image Science and Engineering** (3) II Properties of optical images and image forming systems; acquisition and manipulation of digital images; two-dimensional Fourier representation; image quality criteria; introduction to image processing. P. 340.

526. **Modern Filtering and Signal-Processing Techniques** (3) II Operational amplifier circuits, nonideal amplifier limitations, active RC filter design, nonlinear wave shaping, switching, A/D and D/A components; interfacing. P. 320.

527. **Holography** (3) I II 1992-93 (Identical with Opti. 527)


530. **Optical Communication Systems** (3) II Physics of optical communication components and applications to communication systems. Topics include fiber attenuation and dispersion, laser modulation, photo detection and noise, receiver design, bit error rate calculations, and coherent communications. P. Stat. 361, E.C.E. 340, 352, 381; CR. 431.

531. **Image Processing Laboratory for Remote Sensing** (3) I Techniques and applications of digital image processing in remote sensing, multispectral image enhancement and analysis, classification, feature extraction for cartography, rule-based systems for mapping from imagery. 3R, 1L. (Identical with Opti. 531)

532. **Computer Vision** (3) I Computer pattern recognition and scene analysis. Theory, algorithms, and applications of computer vision and artificial intelligence. Biological vision models. P. 340. (Identical with Opti. 532)

533. **Digital Image Processing** (3) I Image statistics, models, transforms; enhancement and restoration; coding; tomography. P. 425/525, 503. (Identical with Opti. 533)

534. **Electrical and Optical Properties of Semiconducting Materials** (3) I (Identical with M.S. E. 534)

535. **Noise in Communications Systems** (3) I II Principles of communication in the presence of noise; discussion of basic statistical techniques, noise sources, SNR, and error rates. Credit is allowed for this course or for 538 but not for both. P. 431, Stat. 361.

536. **Introduction to Coding Techniques** (3) I Error-correcting codes used in modern digital communications systems, with emphasis on hardware implementations and performance on real channels. P. 271a and Stat. 361.

537. **Digital Transmission and Telephony** (3) Spectrum control, synchronization, and multiplexing in digital transmission systems. Topics include line coding, scrambling, spread spectrum, time-division multiplexing, frequency division multiplexing, timing recovery, frame synchronization, jitter, and echo cancellation. P. Stat. 361 and E.C.E. 431.

538. **Digital Communications Systems** (3) II Digital modulation techniques for the Gaussian white noise channel, emphasizing optimal demodulation methods analysis of error rates, and signaling techniques over finite bandwidth channels. Credit is allowed for this course or for 535 but not for both. P. 503.

539. **Algebraic Coding Theory** (3) I II 1991-92 (Identical with Math. 539)


542. **Digital Control Systems** (3) I II Modeling, analysis, and design of digital control systems; A/D and D/A conversions, Z-transforms, time and frequency domain representations, stability, microcomputer-based designs. P. 441.


545. **Decentralized Control and Large-Scale Systems** (3) I II 1991-92 Introduction to large-scale systems, definitions and special problems, modeling and model reduction, structural properties, decentralization of control and information, hierarchical and multi-level controllers. P. 501.

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

550. **Analog Integrated Circuits** (3) I Non-switching aspects of analog integrated circuits using bipolar or CMOS technologies. Biasing, DC behavior, small signal behavior. Emphasis on use of physical reasoning, identification of circuit functions, and use of suitable approximations to facilitate understanding and analysis.


552. **Solid-State Devices** (3) I II Basic semiconductor physics and materials, PN junctions, metal semiconductor junctions/contacts. BJTs and MOSFETs, device operation, terminal behavior and frequency response, device models. P. 352, 451.

553. **Active Linear Circuit Design** (3) I Design of discrete and integrated analog solid-state circuits, DC, wide-band, power transconductance, and operational amplifiers; computer simulations; applications. P. 351, 352.

554. **Electronic Packaging Principles** (3) I II Introduction to problems encountered at all levels of packaging: thermal, mechanical, electrical, reliability, materials and system integration. Future trends in packaging. (Identical with A.M.E. 554 and M.S.E. 554)

555. **VLSI Chip Engineering** (3) I Layout methods and tools for MOSFET and bipolar IC, statistical circuit design techniques, circuit mod-
els for SPICE simulation, ESD and latch-up protection, exercises and term project in design of a chip, including SPICE simulation on mainframe computer and chip layout using modern CAD system on work station. P, 458.

556.* Optoelectronics (3) I Properties and applications of optoelectronic devices and systems. Topics: radiation sources, detector circuits, fiber optics, and electro-optical components. P, 352; CR, 482.

557a-557b. Integrated Circuit Technology (3-3) 557a: Theory of diffusion, oxidation, processing, etc. 557b: Experiments in diffusion, oxidation, processing, etc., fabrication of an integrated circuit. P, 458. (Identical with M.S.E. 557a-557b)

558. Vacuum System Engineering (3) II Rarefied gas dynamics, pumping, gauging and systems as they apply to micro-electronic device and thin-film fabrication. Materials and techniques for ultraclean and ultra-high vacuum processing. P, 557b or consult department before enrolling.

559.* Laser Principles and Devices (3) I Introduction to the characteristics of laser radiation including Gaussian beam propagation, ABCD matrix method, and resonators. Material requirements for stimulated emission, light amplification and threshold. Also covered: basic types of laser systems with an emphasis on semiconductor lasers. P, 352; CR, 482.

560. Aerosol Science and Engineering (3) I 1991-92 (Identical with Ch.E. 560)


562. Plasma Processing (3) II Practical methodology of plasma etching, sputtering, and plasma enhanced CVD. Plasma physics and plasma chemistry. RF and DC discharges. P, 557 or consult department before enrolling.

564.* Operating System Concepts (3) I Fundamental issues in the design, implementation and evaluation of operating systems. Topics include process models, concurrency control algorithms, resource management and an introduction to distributed systems concepts. P, 371, 372.

565.* Microelectronics Packaging Materials (3) II (Identical with M.S.E. 565)

566. Computer Network Design (3) II Fundamental issues in the design, implementation and evaluation of distributed computer programs. Focus on understanding, using, and designing upper-level network protocols and interfaces. Topics include OSI, TCP/IP and SNA protocols, and the TLI and socket interfaces. P, 564, 578.

568.* Photovoltaic Systems Engineering (3) I (Identical with N.E.E. 568)

569.* Computer Architecture and Organization (3) I Fundamentals of computer architecture and organization, computer design methodologies, processor organization and design, control design, microprogramming, memory organization and design, virtual memory concept, inter- and intra-system communication, bus structure, input/output, operating system role, parallelism in computer architecture. P, 371.


571a-571b. Digital Systems Design (3-3) 571a: Computer organization and architecture; control unit design, microprogramming, input/output, interface design, fault tolerance, associative, cache, and virtual memory, RISC architectures. (Identical with C.Sc. 571a-571b)


573.* Software Engineering Concepts (3) II In-depth consideration of each of the phases of the software project life cycle. Object-oriented design and programming. Includes a large scale software development project involving groups of students. 2R, 3L. P, 371.

574a-574b.* Computer-Aided Logic Design I I 1991-92 Tabular minimization of single and multiple output Boolean functions, NMOS and CMOS realizations, synthesis of sequential circuits, RTL description, laboratory exercises. P, 271a, 574b: Standard cell layout, gate and switch level simulation, level mode sequential circuits. VLSI testing, CAD tools, laboratory projects. (Identical with C.Sc. 574a-574b)

575. Object-Oriented Simulation/Discrete Event Models (3) II Introduction to object-oriented simulation methodology and its implementation on multi-processors. Modular hierarchical discrete event model design and mapping onto distributed simulator architectures. Prior course in simulation recommended.

576. Knowledge-Based System Design (3) II Provides a framework for systematic design of systems and for constructing computer-aided environments to support engineering design activities. Topics include: design methodologies; introduction to knowledge-based design; system design and simulation modeling, knowledge-based model of design, representing designs and design knowledge, design model synthesis, concepts for design evaluation, learning and creativity in design systems. A large-scale term project is central to the course. P, 479, 473.


579. Artificial Intelligence and Simulation (3) I Incorporating expert systems concepts and artificial intelligence into simulation modeling and systems design environments. Provides a framework for applying simulation methodology and AI concepts in a unified manner. P, 575.

581a-581b. Electromagnetic Field Theory (3-3) 581a: I Time-harmonic fields; fundamental theorems and concepts; rectangular and circular waveguides and resonators; apertures in ground planes, cylinders, and wedges; scattering by cylinders and wedges. P, 502 or Math. 422b; 482 or Phys. 415b, 516b; I Spherical geometries; interface problems, perturbation techniques; integral equations; asymptotic techniques; introduction to transient fields, finite elements, and finite differences.

583. Remote Sensing Instrumentation and Techniques (3) II Development of instrumentation, measurement and signal processing techniques required for electromagnetic remote sensing applications with emphasis on atmospheric remote sensing. P, 482. (Identical with Atmo. 583)


587.* Fiber Optics Laboratory (3) II (Identical with Optl. 587)

*May be convened with 400-level course.

589. Atmospheric Electricity (3) II 1991-92 (Identical with Atmo. 589)

636. Information Theory (3) III 1992-93 Definition of a measure of information and study of its properties; introduction to channel capacity and error-free communications over noisy channels; rate distortion theory; error detecting and correcting codes. P, 503. (Identical with Math. 636)


650. Advanced Analog Circuits (3) II Advanced topics in bipolar and CMOS analog integrated circuits including both switching and nonswitching applications. Voltage references, DAC and ADC systems, instrumentation amplifiers, sample-hold circuits, switched-mode power supply regulators. P, 550.

651. Advanced Topics in Semiconductor Devices (3) III Preparation of approximately three research reports and presentation on semiconductor topics of current interest. P, consult department before enrolling.

652. Advanced Solid-State Devices (3) I Analysis and design of devices including BJTs, MOSFETS, MESFETS, MODFETS, microwave devices, and photonic devices. P, 552.


671. Parallel Processing: Architectures and Algorithms (3) II Parallel computer architectures, architectural classification schemes, techniques for parallel processing, pipeline processing, multiprocessor structures and applications (SIMD and MIMD machines), study of parallel algorithms, parallel processing applications, neural networks, and data flow computing. P. 569, knowledge of computer architecture and digital systems.

672. Computer-Aided Design Algorithms and Techniques for VLSI (3) I Introduction to VLSI design, combinational and sequential logic synthesis, layout generation and optimization, logic and timing simulation, design styles. P. 474/574.


678. Integrated Telecommunication Networks (3) I Analysis and design of integrated voice, data, and image networks for integrated telecommunication applications. Protocols for LANs, ISDNs, WANS, MANs, and interoperable networks. ISO-based network software design for applications. P. 566, 673.

679. Advances in Knowledge-Based Systems (3) I Forum for discussion of advanced topics in the forefront of research. Lectures and student presentations. P. 575 or 567 or 570.


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**Elementary Education**

*(See Education)*

**Engineering and Mines (ENGR)**

Geology Building, Room 134 (602) 621-6032

Within the colleges of Engineering and Mines, and Agriculture, programs are offered leading to the Master of Science (M.S.) and the Doctor of Philosophy (Ph.D.) degrees as indicated in the following list of departments and majors:

- Aerospace and Mechanical Engineering
- Chemical Engineering
- Civil Engineering and Engineering Mechanics
- Electrical and Computer Engineering
- Engineering and Biosystems Engineering
- Materials Science and Engineering
- Mining and Geological Engineering
- Nuclear and Energy Engineering
- Systems and Industrial Engineering

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**Engineering Mechanics**

*(See Civil Engineering and Engineering Mechanics)*

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**English (ENGL)**

Modern Languages Building, Room 445 (602) 621-1836


506. Modern Grammar and Usage (3) I II Introduction to the nature of grammar, and approaches to its description. Scope also includes the social and historical factors which influence the form and use of English in various contexts, both in speaking and writing.

508. English as a Second Language in Linguistic and Literary Theory (3) I II Methodology for the teaching of English as a component of bilingual education; grammar, phonology, and syntax as they apply to the teaching of language skills.


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

512. Teaching of the English Language (3) I II Preparation of professional literature for publication.

515a-515b. History of Criticism (3-3) 515a: Plato through the 19th century. 515b: Modern criticism.

516. The Nature of Literature (3) I What literature is and does, as exposed in theories of writing and in self-conscious literary works.

520. History of the German Language (3) II 1951-92 (Identical with Ger. 520)

521. Contemporary American Usage (3) I II S Consideration of the varieties of contemporary American language usage, social and regional, written and oral. P, upper-division standing.


525. Beowulf (3) II (Identical with Ger. 525)

526. Advanced Studies in Chaucer (3) II


531. Advanced Studies in Shakespeare (3) I

533. Studies in the Renaissance (3) [Rpt./1] I

534. Advanced Studies in Milton (3) I

541. Studies in the Restoration and Eighteenth Century (3) [Rpt./1] I

543. Mexican-American Literature (3) II (Identical with Span. 543)

545. Introduction to TESL: An Overview (2) I The development of English as a second language with emphasis on current trends, the influence of linguistic theory, and the international role of English.

549a-549b. *Folklore (3-3) 549a: Forms of verbal folklore: myth, legend, folktale, riddle, proverb, joke, folksong, ballad, etc. 549b: Nonverbal folklore: custom, belief, folk art and craft, food, medicine, dress, festival, and drama. (Identical with A.In.S. 549a-549b and Anth. 549a-549b)


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


577. *American Indian Literature (3) I II (Identical with A.In.S. 577)

585. Linguistics and Computer-Assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

591. Preceptorship

a. Methodology of Essay Writing (1) I II Designed for graduate teaching assistants in English.

b. Methodology in Critical Reading and Writing (1) I II Designed for graduate teaching assistants in English.

595. Colloquium

a. Rhetoric of Exposition (1) I II Designed for graduate teaching assistants in English.

b. Rhetoric of Literature and Critical Writing (1) I II Designed for graduate teaching assistants in English.

596. Seminar

a. Medieval Literature (3) [Rpt./2] I II

b. Renaissance Literature (3) [Rpt./2] I II

c. Restoration and Eighteenth-Century Literature (3) [Rpt./2] I II

d. Nineteenth-Century British Literature (3) [Rpt./2] I II

e. Twentieth-Century British Literature (3) [Rpt./2] I II

f. American Literature (3) [Rpt./2] I II

g. Comparative Literature (3) [Rpt./2] I II

h. Modern Literature (3) [Rpt./24 units] I II Open to creative writing majors only.

i. Germanic Linguistics (3) [Rpt./1] I II

j. Second Language Acquisition Research (3) [Rpt./2] I II

k. Methods and Materials of Literary Research (3) [Rpt./2] I II

l. Theories of Criticism (3) [Rpt./2] I I

m. Studies in the Oral Tradition (3) [Rpt./9 units] I I (Identical with A.In.S. 596m)

d. Discourse Analysis (3) I

w. Women's Studies (3) [Rpt./2] I I (Identical with W.S. 596w)

597. Workshop

a. Southern Arizona Writing Project (3-9) [Rpt./12 units] I II S (Identical with L.R.C. 597a, which is home)

b. The Teaching of English (3) I II S [Rpt.] (Identical with L.R.C. 597o)

c. Research and Composition (3) I

604. Writing Project in Fiction (1-6) [Rpt./24 units] I II For M.F.A. candidates working on the book-length writing project in fiction.
609. Writing Project in Poetry (1-6) [Rpt./24 units] I II For M.F.A. candidates working on the book-length writing project in poetry.


613. Second Language Acquisition in Formal Contexts (3) I Foundations, theory, and methodology in English as a second language. (Identical with L.R.C. 613)

615. Second Language Acquisition (3) I Survey of major perspectives on second language acquisition processes, including interlanguage theory, the Monitor Model, acculturation/ pidginization theory, cognitive/connectorist theory, and linguistic universals. Analysis of research from the different perspectives includes consideration of grammatical, pragmatic, and sociolinguistic dimensions of language learning.


693. Internship

696. Seminar
b. Linguistics (2 to 4) I (Identical with Ger. 696b, which is home) c. Folklore (2 to 4) I (Identical with Ger. 696c, which is home) d. History of Rhetoric (3) [Rpt./6] II e. Studies in Rhetoric and Composition (3) [Rpt./6] II

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**English as a Second Language**

*(See English)*

**Entomology (ENTO)**

Forbes Building, Room 410
(602) 621-1151


Associate Professors Robert L. Smith, Assistant Professors Nancy A. Moran, L. Irene Terry, Diana E. Wheeler

Associate Research Scientist David Byrne

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees in entomology. Disciplinary specialization 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, taxonomy and toxicology. Research opportunities with insects also exist in the departments of Biochemistry, and Ecology and Evolutionary Biology, and through the Committee on Neuroscience. The Center for Insect Science provides opportunities for collaborative research at the University of Arizona, Arizona State University and the Carl Hayden Bee Research Center. Facilities for field studies include agricultural centers around the state and a farm with an entomology lab just three miles from campus. Natural habitats can be studied from college field centers nearby in the Sonoran Desert, and in the rangelands and canyons of the Santa Rita Mountains. Several other excellent field centers are available in the diverse biomes of southern Arizona.

Admission requirements include the completion of an undergraduate major in the biological sciences. The undergraduate program should include course work in physics, organic chemistry, and mathematics, and the evolutionary, ecological, organismic, cellular and molecular aspects of biological systems. 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. Master’s degree candidates will be required to take Ento. 201, 2 units of seminar and two courses selected from Ento. 504, 507, 511, 516, and 544. A thesis is required. The doctoral program requires four semesters of excellent field center work, and three courses selected from Ento. 201 and three courses selected from Ento. 504, 507, 511, 516, and 544, plus 6 credits from upper-division courses offered by the Department of Entomology. The pursuit of original research and presentation of a dissertation is a vital part of the doctoral program.

503R.* Biology of Animal Parasites (3) I (Identical with V.Sc. 503R)

503L.* Parasitology Laboratory (1) I (Identical with V.Sc. 503L)

504.* Insect Morphology (4) I 1992-93 External and internal anatomy as related to identification, function and phylogeny of insects and other arthropods; modifications in development and habits peculiar to the insects. 2R, 6L, P 201R or invertebrate zoology. Wheeler


507R.* Insect Physiology (3) II 1992-93 Introduction to the diverse and unique ways insects solve physiological problems. A whole-animal approach will be used centered around various aspects of an insect’s life (i.e., growing, flying, reproducing). P, 201; CR, 507L; biochemistry recommended. Hagedorn/Chapman


508.* Insecticide Toxicology (3) II 1991-92 Insecticides and related chemicals; their modes of action, detoxication, resistance in arthropods, and environmental distribution and effects. P, 3 units of organic chemistry or biochemistry. (Identical with Tox. 508) Feyereisen


543.* Insect Neurobiology (3) I The structure, function and development of the insect nervous system. Basic concepts in neurobiology and presentation of insects as model systems of neurophysiology, development and behavior. P, M.C.B. 181, Ecol. 182. Robin

554.* Insect Ecology (3) I 1992-93 Determinants of population size and distribution, including processes occurring within and between populations, abiotic factors. 2R, 3L. Field trips. P 201R. (Identical with Ecol. 554) Moran

552.* Medical-Veterinary Entomology (4) [Rpt./3] II 1992-93 Survey of arthropods of public health and veterinary importance, with emphasis on transmission dynamics of pathogens, biometrics of vector populations, and current control concepts. 3R, 3L, P. 201R; parasitology recommended. (Identical with V.Sc. 552) Cupp

568.* Insect Pest Management (3) I Principles underlying the management of arthropods in agricultural systems. P 201R.

570.* Biological Control (3) II Principles of the biological control of arthropod pests and weeds, emphasizing their application to agricultural and rangeland entomology. P 444 and 488. Watson

*May be convened with 400-level course.

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

696. Seminar
a. Entomology (1) [Rpt./6] II

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**Environment and Behavior (ENV)**

Psychology Building, Room 517
(602) 621-7430

Committee on Environment and Behavior (Graduate)

Professors Robert Bechtel, Chair (Psychology), Charles Albanese (Architecture), Terry Daniel (Psychology), Donald Davis (Hydrology), William Havens (Renewable Natural Resources), Robert Hershey (Architec-
The graduate interdisciplinary program in epidemiology offers the opportunity for study in the scientific discipline concerned with the causes and prevention of disease in human populations. Advances in clinical medicine, laboratory science, environmental health, nutrition, statistics, computer data processing and the basic understanding of the pathogenesis of disease enable epidemiology researchers to better examine causes of disease and to evaluate more effective strategies for disease prevention and control. Multidisciplinary collaborations between committee faculty and members of university departments and state and national health institutions provide classroom and community training opportunities. To accomplish this goal, faculty committee members with overlapping expertise from several health science departments have been selected to direct courses and research.

Degrees
The Graduate Committee on Epidemiology offers a major in epidemiology for the Master of Science and Doctor of Philosophy degrees.

Admission Requirements
In addition to an undergraduate degree, applicants should provide scores of the Graduate Record Examination. Three letters of recommendation are required. For additional information, contact Dr. Thomas E. Moon.

Courses
See the Department of Family and Community Medicine under Medicine for a listing of most epidemiology courses.

Ethnic Studies
(See American Indian Studies)

Exercise and Sport Sciences
(See Health-Related Professions)

Family and Consumer Resources
(FCR/MCS/ID/HEE/COUN/FS)

Program Areas:
Counseling and Guidance
Family Studies
Home Economics Education
Interior Design
Merchandising and Consumer Studies

Programs
Counseling and Guidance: The division offers programs leading to the Master of Arts degree. Concentrations are available in career counseling, marriage, family and agency counseling. A minor program of fifteen units minimum is available for doctoral students majoring in other fields.

Forms and statements regarding application procedures for master's programs with a major in counseling and guidance are obtainable on request from the Division of Educational and Professional Studies. Master's degree applicants must submit a personal data blank, a candidate's statement, letters of recommendation and scores of the Graduate Record Examination. All application materials for fall admission must be received by March 1.

Individual master's programs will be planned and approved by an advisor. These may vary both in course work and in total units, depending upon the area of concentration and upon past experience and training.

Family Studies: Family studies involves the scientific study of family structures, interactions,
and outcomes, emphasizing change over time in individual, interactional, and group level phenomena. Emphases are available in interpersonal relationships, human development, or family economics/consumer resource management.

When students are accepted into the concentration in family studies within the Family and Consumer Resources major for the Ph.D., it is assumed that all 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 of the School of Family and Consumer Resources.

Home Economics Education: Programs leading to the Master of Science degree and the Master of Home Economics Education degree with a major in home economics education are available. A minor in home economics education is also available for doctoral students with majors in other disciplines. The Master of Science degree program requires a thesis and no fewer than twenty units in home economics education, family and consumer resources, or education for 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 to six units. Modification of these requirements may be made, with the approval of the student's graduate committee and the director of the School, after consideration of the student's preparation and professional objectives.

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 with varied, 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 deficiencies.

Applicants must submit to the Interior Design admissions committee the following: (1) a two-page, typed statement of the goals and reasons for desiring graduate study in interior design; (2) a resume including a detailed record of professional experience in interior design or related fields; (3) a slide portfolio of creative studio work including complete interior design projects; and (4) three letters from academic and/or professional references. No application will be considered until all of these items have been submitted.

Students are encouraged to accumulate a minimum of one year of professional work experience prior to undertaking graduate study. Applicants without professional work experience will be required to intern in the field during their first year of graduate study.

This program requires a minimum of 34 graduate units. However, because the program is tailored to each student's goals and abilities, additional units may be required. The graduate study program will be planned by the student in consultation with their designated major professor.

Merchandising and Consumer Studies: For the Master of Science degree with a major in family and consumer resources, a concentration in merchandising and consumer studies is available. Students are required to complete 34 units including statistics and research methods plus four to six units for the thesis. This program prepares students for employment in retail firms, consumer service firms, teaching at the secondary-school, community-college, or university level, and, for promotional and educational or testing and research positions with industrial and commercial companies. A new sequence of courses focusing on merchandising and consumer studies is being designed as the main emphasis; contact the school for information.

Family and Consumer Resources (FCR)

565. * Women in International Development (3) II (Identical with Anth. 565)
566. Seminar

z. Family and Consumer Resources (1-3) [Rpt./1] I II

*May be convened with 400-level course.

Division of Merchandising, Consumer Studies and Design

N. Reich, Chairperson

Merchandising and Consumer Studies (MCS)

534. * The Fashion Industry (3) II Operations of the wholesale to retail channel, and development of retail strategy by different types of retail outlets. P. 304, Mktg. 361.
544. * Dimensions of Clothing Behavior (3) II Analysis of psychological, social, cultural, historical, economic and aesthetic dimensions of clothing reported in literature. P. 325, Soc. 101, Psyc. 101, Econ. 201a.
545. * Clothing for Special Needs (3) S Clothing and accessories for special needs; based upon research. (Identical with Gero. 545)
546. * Consumer Economics (3) I II Study and application of consumer economics under existing market conditions. P. Econ. 201a. (Identical with A.Ec. 546)

*May be convened with 400-level course.

Interior Design (ID)

505. * Barrier Free Design (3) II Current research in architecture, interior design, product design, physical therapy, behavioral science and rehabilitation reviewed and applied in design problem-solving.
555. * Visual Merchandising and Display (3) S All aspects of displaying merchandise, including window display, interior display, color and lighting techniques, line and composition, three-dimensional presentation, fixtures and systems, planning and layout, scheduling and promotion. P. 115 or Art 101.

575. * Public Space Design (4) I Studio projects with special focus on interior environments designated for public usage. Includes programming, design development, project documentation and organization, working drawings and presentation techniques. P. 375, 385.
585. * Ethics and Practice for Interior Design (3) II Readings in the interior fields, with emphasis on ethics, business organization, communication, and professional development. Includes study of billing and fee structures; writing proposals, contracts, specifications; and highlights various career paths associated with the design profession. P. 475.

588. * Advanced Public Space Design (4) II Studio projects with special focus on large-scale multifunction public space environments; design development by teams. P. 475.

Division of Educational and Professional Studies

B. Newton, Division Chairperson

Home Economics Education (HEE)

528. * 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.
538. Extension Education (3) I (Identical with A.Ed. 538)
539. * Non-Formal Education (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 (1-3) [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 Economic Programs (1-2)
i. Video Communications and Methods (1-2) [Rpt./2] (Identical with A.Ed. 597i, which is home)
Counseling and Guidance (COUN)

503. Principles of Adlerian Psychology (3) I
S Techniques for the study of human behavior; implications for improving adult-child relationships, with emphasis on Adlerian principles. P. 6 units of social science.

504. Counseling and Human Sexuality (3) S
Sexual function, dysfunction, and disorders in context of individual and couple; interview techniques and intervention strategies. P. 6 units of counseling or related area.

555. Addictions Counseling (3) S An analysis of issues in addictions counseling ranging from various theoretical positions, information regarding diagnosis of addictive personality, treatment programs, and research. P. 6 units of counseling or related area.

557. Methods in Marital Therapy (3) I (Identical with FS. 557)

570. Counseling the Adult (3) I
Adult crisis, midlife changes and developmental patterns; counseling techniques and intervention strategies. P. 6 units of counseling or related area.

571. Counseling Women (3) II
Examination of the counseling needs of contemporary women and current types of intervention designed to meet these needs. P. 6 units of counseling or related area. (Identical with W.S. 571)

597. Workshop
b. Self-Management Techniques (3) S P. 6 units of counseling or related area.

601. Foundations of Counseling (3) I
Relationships 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) I
Methods of appraising and reporting individual behavior, with emphasis on nonpsychometric data. Open to majors only.

623. Testing in Counseling (3) I
Evaluation and selection of psychological tests for guidance; use of psychometric data in counseling. Open to majors only.

631. Career Counseling (3) I
Theories of vocational development; types, sources, and use of occupational and educational information in career counseling and decision making. P. 601 or 223.

644. The Counseling Process (3) I
Introduction to theories of counseling; coalition and interpretation of counseling data; the counseling process; study of cases. P. 601, 622.

645. Theories of Counseling (3) II
Rationale, development, and research underlying major counseling theories. P. 631, 644.

647. Premarriage and Marriage Counseling (3) I
Contemporary issues, concepts, and procedures in premarriage and marriage counseling. P. 622.

648. Procedures in Family Counseling (3) I
Theory and process in family counseling; problem solving techniques applied to parent-child conflict; lab. experience. P. 403.

672. Cross-Cultural Counseling (2 to 3) II
Issues in counseling culturally different persons. Open to majors only. P. 601, 622.

683. Group Counseling (3) I
Theory and process in group counseling; applications in community and mental health settings; lab. experience. P. 644.

696. Seminar
a. Ethics and Professional Practice (3) I
Open to majors only. P. 601, 622, 644.

537. Analysis of Family Studies (3) I
An analysis of major research topics; critical research issues related to the fields of family studies. P. 601, 622.

547. Advanced Child Development (3) I
In-depth examination of various dimensions of human growth and development. P. 223; 6 units of psychology. P. 557.

557. Methods in Marital Therapy (3) I
Theories and principles of counseling for premarital, marital, and group counseling situations. (Identical with Coun. 557)

566. Family Economics (3) I
Analysis of the family as an economic-decision-making unit within the larger economic system. P. Econ. 201b.

567. Theories of Human Development (3) I
Analysis of major paradigms and world views influencing the study of human development. Overview of key issues and controversies arising in the field as well as evaluations of specific theories and specific theorists.

573. Theories of the Family (3) II Major theories of the family to include theory construction, historical roots of family theories, and classic and contemporary family theories. P. 9 units of family studies, psychology, or sociology.

577. Genetic Basis of Normal and Deviant Traits (3) II
Explores methods of studying genetic influences on human traits and summarizes research findings on normal traits, such as sociability and IQ, and on deviant traits such as criminality. Implications for fields of family studies, sociology, and psychology are considered.

587. Advanced Family Relations (3) II
Critical analysis of select studies and current research in family relations. P. 337, or Soc. 321.

607. Topics in Family Studies (1 to 3) [Rpt/3 I
Variable content: cognitive development, biographical theories of development, role theory, middle childhood, and others.

637. Trends in Human Relations (3) Philoso-
phy, content, and resources for understanding, teaching and working in the field of human relations.
646. Theories of Family Economic Behavior (3) I Analysis of theories relevant to family economic behavior including theories on poverty, economic well-being, family systems, and decision-making. Emphasis on social psychological concepts.

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 O. Bierweig, William T. Carleton, Nestor R. Roos (Emeritus)
Associate Professors Erich K. Bleck (Emeritus), Joseph S. Gerber (Emeritus)

The department offers programs leading to the Master of Science degree with a major in finance. Concentrations are available in finance or real estate. The department also participates in the programs leading to the Master of Business Administration degree and the Doctor of Philosophy degree with a major in management. For information concerning these degrees, see Requirements for Master's Degrees/Master of Education elsewhere in this catalog. The department cooperates with the Arizona Center for Medieval and Renaissance Studies. Admission to graduate programs in French requires the completion of a bachelor degree with a major in French. Applicants must submit scores on the aptitude 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 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 Demorest (Emeritus), Monique Wittig
Associate Professors Robert Ariew, Edward G. Brown, Ingeborg M. Kohn, Henri Servin, Gianni Spera, Ronnie H. Terpening
Assistant Professors Irene D'Aimeida, Lise Leibacher

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. Doctoral minors are available in French and Italian.

Research and Finance (1-3) \[\text{Identical with Acct. 511}\]

Financial Decision Making Under Uncertainty (3) II Theoretical and applied financial economics relating to uncertainty in markets, information, and choice. P. 513.


533. Finance for New Ventures (3) I Value maximization; simulation of value distribution; sources of venture capital; timing of initial public offering; new venture ownership structuring. Open only to students in the entrepreneurship program. P. 511, Econ. 500a-500b, Mktg. 500. (Identical with M.A.P. 537)

539. Planning of New Ventures (3) II (Identical with M.A.P. 539)

569. Information and Financial Decision Support for Investment Planning (3) I II (Identical with Acct. 569)

601. Financial Decision Making Under Uncertainty (3) II Theoretical and applied financial economics relating to uncertainty in markets, information, and choice. P. 513.


695. Colloquium
a. Research and Finance (1-3) \[\text{Rpt./4}\] I II

696. Seminar
a. Investments (3) \[\text{Rpt./1}\] I II
b. Financial Markets (3) \[\text{Rpt./1}\] I II
c. Corporation Finance (3) \[\text{Rpt./1}\] I II
d. Financial Institutions (3) I II
e. Financial Theory (3) \[\text{Rpt./1}\] I II
f. Research Methods (3) \[\text{Rpt./1}\] I II

Food Science
(See Nutrition and Food Science)

Foundations of Education
(See Education)
data bases. Issues in the history, sociology, and politics of the professional practice of language and literature study in American universities.


514a.* Teaching of Modern Languages (3) II (identical with T.T.E. 514)

515a-515b. Literature of the 20th Century (3-3) 1992-93 515a: Novel. 515b: Poetry and drama. 515a is not prerequisite to 515b.

516a-516b. Literature of the 19th Century (3-3) 1992-93 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) 1991-92 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) 1992-93 518a: Literature and culture in the first half of the 17th century. 518b: The Classical ideal. 518a is not prerequisite to 518b.

519a-519b. Literature of the 16th Century (3-3) 1991-92 519a: Early Renaissance, Reforma, Rabelais, the Pleide. 519b: The Humanists, Montaigne, D'Aubigné, the drama. 519a is not prerequisite to 519b.


522.* Introduction to Romance Philology (3) I (identical with Span. 522)


552.* French Literature of Quebec (3) II 1992-93 Comprehensive study of the most significant literary expression in Quebec. P. 350.

553.* Culture and Civilization of North Africa (3) I 1992-93 Historical, religious, social, literary and artistic influences on the civilization of North Africa. P. 305b if 553 is taught in French.

554.* Francophone Literature of the Maghreb and Lebanon (3) II 1992-93 Francophone literature of Algeria, Lebanon, Morocco and Tunisia. P. 305b if taught in French.

579. Problems in Teaching College French (1 to 3) I II Methodology course in lower-division college pedagogy. Discussion of broader issues of language, pedagogy, academia, the history of foreign language education, college teaching as a career.

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt.] II

Geneticists from various departments comprise the interdepartmental Committee on Genetics, which offers programs leading to the Master of Science and Doctor of Philosophy degrees in genetics. The areas of study emphasized by the committee are molecular and cellular genetics, cytogenetics and population genetics. Research opportunities include bacterial and bacteriophage genetics, gene regulation, developmental plant genetics, and animal and plant cytogenetics, somatic cell genetics, cancer and clinical cytogenetics, quantitative genetics and animal breeding, ecological and evolutionary genetics, population genetics, human genetics, and biometrical principles as applied to individuals and populations.

Admission requirements include: completion of bachelor's degree with one year of biology, courses in genetics, ecology, physiology and developmental biology, chemistry through organic, mathematics through integral calculus, introductory physics and statistics. In addition to materials required by the Graduate College, applicants are required to furnish the committee with completed Committee on Genetics application forms, GRE scores on quantitative and verbal tests, and three letters of recommendation from persons qualified to evaluate the applicant's scholarly potential. The deadline for receipt of application forms for fall admission is April 1 and for spring admission, November 1.

Courses are available in a number of departments depending on the interests of the students.

513. Quantitative Genetics (3) I 1992-93 (identical with An.S. 513)

515.* Somatic Cell and Molecular Genetics (2) II (identical with M.C.B. 515)

520. History of Genetics (1) I 1992-93 Experiments and discoveries which have led to the present state of knowledge in the various areas of genetics. P. Ecol. 320 or 321.

523.* Cytogenetics (3) II (identical with Ecol. 523)

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

525. Speciation (2) II (identical with Ecol. 525)

528R.* Advanced Microbial Genetics (3) II (identical with M.C.B. 528R)

533.* Human Genetics (3) I Genetic theory and technique, as applied to man; methods of analysis of genetically determined cytological and biochemical differences in individuals and populations. 2R, 3L. P. Ecol. 320 or 321. (Identical with Ecol. 533) Ward

535.* Evolution (3) I (identical with Ecol. 535) *May be convened with 400-level course.

539. Statistical Methods (4) I II (identical with A.Ec. 539)

545. Concepts in Genetic Analysis (3) I (identical with M.C.B. 545)

555. Molecular Mechanisms of Development (3) II 1992-93 (identical with M.C.B. 555)

568. Nucleic Acids (4) I (identical with Bioc. 568)

570. Molecular Genetics (3) I 1991-92 (identical with Micr. 570)

571. Molecular Gene Cloning (3) II 1992-93 (identical with Micr. 571)
574. Advances in Mammalian Genetics (2) [Rpt/1] I 1992-93 (Identical with Bicc. 574)

589. Cancer Genetics and Cytogenetics (3) I 1991-92 (Identical with C.Bio. 589, which is home)

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

627. Advanced Genetics (3) I 1992-93 (Identical with P.I.S. 627)

635. Advanced Cytogenetics (4) II 1992-93 (Identical with P.I.S. 635)

638. Genes of Plant Cell Cultures (2) I 1992-93 (Identical with P.I.S. 638)

666. Human Microevolution (3) II 1992-93 (Identical with Anth. 666)

670. Recent Advances in Genetics (2) I Recent advances in the field of genetics. (Identical with Ecoll. 670)

Geography and Regional Development (GEOG)
Harvill Building, Room 454 (602) 621-1652

Professors Michael E. Bonine (Near Eastern Studies), Terence Burke, Robert D. Carpenter (Emeritus), Lay J. Gibson, Andrew M. Kirby, Lawrence D. Mann, Gordon F. Mulligan, Leland R. Pederson, Richard W. Reeves, Thomas F. Saarinen, Dan Stanislawski (Emeritus), Andrew W. Wilson (Emeritus)

Associate Professors David A. Plane, Head, Robert Altschul, Stuart E. Marsh (Arid Lands Resource Sciences)

Assistant Professor Sally 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 are required to submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Admission to the Doctor of Philosophy degree program requires the recommendation of the committee administering the final examination for the Master of Arts degree, or, if the master's degree was earned elsewhere, admission is subject to passing a qualifying examination during the first semester of resident graduate study.

Degrees

Master of Arts: A total of 30 units of graduate credit, to include (1) a core of 9 units made up of 500, 657, and 689; (2) a minimum of 12 units of graduate work in geography exclusive of both core and thesis, at least 6 of which must be in courses or seminars exclusive to graduate students, i.e., not convening 400/500 courses, and not independent studies; and (3) an additional 9 units of approved electives, which may include up to 6 units of thesis, which is optional. Students electing the thesis option must pass a final oral examination; those electing the non-thesis option must pass a written and oral comprehensive examination.

Master of Education: A total of 17 units of geography including 500 and 657, and 11 additional approved units, to include at least one regional and one topical course. No thesis is required, but candidates must pass a 3-hour written examination and an oral examination. For further information concerning this degree, see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Master of Science (Major in Planning): The department cooperates with the Graduate Committee on Planning in offering the regional planning concentration for students seeking professional preparation for careers in planning for urban and rural regions. For further information, see Planning elsewhere in this catalog.

Doctor of Philosophy: Doctoral students must complete the requirements for the master's degree and in addition a minimum of 18 units in geography (exclusive of the dissertation) of which at least 12 units must be in courses or seminars exclusive to graduate students, i.e., not convening 400/500 courses, and not independent studies. Students must also achieve high-level competence in two fields of concentration, one topical and one regional, and 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. Regional concentrations available are Anglo-America (or United States), arid lands, and Latin America. At least one research tool (e.g., language, statistics/computer science) is required for the Ph.D. degree. This requirement may be met by one of four options: a reading knowledge of French or German and other approved language; high proficiency in the use of one approved language; a reading knowledge of one approved language and 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 and is subject to approval by the student's supervisory committee. The minor or minors must be complementary to the student's program of specialization, and the dissertation should incorporate aspects of both the topical and regional concentrations chosen.

500. Current Geographical Research (3) I Major trends and issues in human and physical geography. Kirby

507.* The American Landscape (3) II Origin and character of the visual aspects of places viewed individually and regionally; changes in habitat, vernacular structures and landscapes, townscapes, countrysides and special features. Field trips. (Identical with L.Ar. 507) Zube

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

510. Development of Regional Planning (3) I Survey of the historical development of the planning profession; the evolution of American planning as a response to urbanization. Open to majors only. Credit allowed for this course or 301, but not for both. (Identical with Png. 510) Mann

511.* Middle America (3) II Land, man, and culture in the major natural and cultural regions of Mexico, Central America, and West Indies. (Identical with L.A.S. 511) Pederson

512.* South America (3) I Physical and cultural bases of South America's geographic patterns, with emphasis on human settlement and problems of resource development. (Identical with L.A.S. 512) Pederson

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

515.* Introduction to Water Resources Policy (3) II (Identical with H.W.R. 515)

516.* Rural Area Development (3) I (Identical with A.Ec. 516)

517.* Introduction to Geographic Information Systems (3) II (Identical with R.N.R. 517)

550. Metropolitan and Regional Planning (3) I Survey and evaluation of concepts and examples, including metropolitan, economic development, state and national, and environmental plans in the U.S. and abroad. (Identical with Png. 550) Mann

553.* Locational Analysis (3) II Industrial location theory and location factors, consumer travel behavior and market areas, geography of economic impacts, location of public facilities. (Identical with Png. 553) Mulligan

555. Urban Systems Analysis (3) II Theoretical and applied analysis of urban growth models, gradients of urban influence, residential and facility decisions, and urban transportation. (Identical with Png. 556) Marston

557.* Statistical Techniques in Geography, Regional Development and Planning (3) I Methods of gathering and analyzing data for the solution of geographical, urban, and regional planning problems, with emphasis on quantitative and statistical techniques used in spatial analysis and cartography, on the one hand, and program planning, on the other. (Identical with Png. 557)

561. Resource Management (3) I Examination and critical appraisal of social and behavioral science aspects of resource management, with special emphasis on factors affecting decision making. (Identical with Png. 561) Saarinen

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

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

565.* Physical Aspects of Arid Lands (3) II The climate, landforms, hydrology, soils and vegetation of deserts, with special emphasis on processes and distribution at micro-to-macro scales. Altschul
567. Geographical Analysis of Population (3) II Population distribution and change; practical methods of demographic analysis, migration, business and planning applications. (Identical with Ping. 567) Plane

571. Problems in Regional Development (3) II Analysis of population growth trends, market areas, the role of transportation in development, regional specialization and economic structure, interregional migration, and regional policy issues. (Identical with A.Ec. 571 and Ping. 571)

581. Computer Cartography (3) II Introduction to the use of computers for map production, with emphasis on cartographic principles and practical experience with several user-oriented mapping programs. (Identical with Ping. 581)

583. Geographic Applications of Remote Sensing (3) II Use of aircraft and satellite imagery for monitoring landforms, soils, vegetation, and land use, with the focus on problems of land-use planning, resource management and related topics. 2R, 3L. Field trip. P two units of remote sensing or equivalent experience. (Identical with Ping. 583) Marsh

596. Seminar k. Risk and Society (3) I (Identical with Anth. 596k, Jour. 596k, H.W.R. 596k)

u. Interdisciplinary Environment-Behavior-Design (3) II (Identical with Env. 596u, which is home)

597. Workshop a. Geography for Teachers (3) S
*May be convened with 400-level course.

605. Planning Theories and Perspectives (3) I A critical examination of normative and methodological assumptions of alternative planning models, with emphasis on developing a perspective on contemporary planning issues. (Identical with Ping. 605) Mann

609. Policy Problems in Structure and Change (3) II (Identical with M.A.P. 609)

611. Projects in Regional Planning (1 to 5) [Rpt./5 units] II Lectures, laboratory, and field projects covering various aspects of professional practice. P, 605, 24 units toward a graduate degree in planning. Field trips. (Identical with Ping. 611)

657. Spatial Analysis (3) II Formal analysis and modeling of spatial structures and processes; conceptual evaluation of point patterns, networks, surfaces and interaction. P, 457 or 557. (Identical with Ping. 657) Mulligan

659. Growth Controls (3) II Current legal and planning techniques to regulate the rate of growth, the sequence of growth, and the eventual total size of towns, regions, and states; concentration on case studies. (Identical with Ping. 659)

689. History of Geographic Thought (3) II History of geographic philosophy and methodology. P, 15 units of geography. Pederson

696. Seminar a. Economic Geography (3) [Rpt./2] II

b. Cultural Geography (3) [Rpt./2] II

c. Physical Geography (3) [Rpt./2] II

d. Historical Geography (3) [Rpt./2] II

e. Area Study (3) [Rpt./3] II

f. Research Methods (3) [Rpt./2] II

g. Urban Geography (3) [Rpt./9] II

h. The General Plan (3) [Rpt./6 units] II (Identical with Ping. 696p)

i. The Land Development Process (3) [Rpt./6 units] II (Identical with Ping. 696p)

Geological Engineering

(See Mining and Geological Engineering)

Geology

(See Geosciences)

Geosciences (GEOS)

Gould-Simpson Building, Room 208

(602) 621-6024


Associated Professors Mark D. Barton, Andrew S. Cohen, Owen K. Davis, Judith Tomman Parrish, Randall M. Richardson, Joaquín Ruiz, Robert B. Singer (Planetary Sciences), Terry C. Wallace

Assistant Professors Lawrence M. Anovitz, Susan L. Beck, George E. Gehrels, Rpy A. Johnson, Eleanor A. Snow

Laboratory of Tree Ring Research

West Stadium Building, Room 109

(602) 621-6469

Professors Malcolm K. Hughes, Director, Bryant Bannister (Emeritus), Jeffrey S. Dean, Harold C. Fritts (Emeritus), William J. Robinson (Emeritus), Charles W. Stockton, Marvin A. Stokes (Emeritus)

Associate Professor Steven W. Leavitt

Assistant Professors Lisa J. Graumlich, Thomas W. Swetnam

The Department of Geosciences offers graduate studies leading to the Master of Science and the Doctor of Philosophy degrees with a major in geosciences. Applicants for graduate degrees must have completed the baccalaureate with a major in geosciences or an allied discipline. All applicants must submit their scores on the General Graduate Record Examination directly to the department, provide three letters of recommendation, and a personal resume including a statement of proposed academic and research activities. Application materials are available from the department.

Degrees

Master of Science: Designed to train students aspiring to professional employment in industry; in local, state or federal government; or in the teaching profession at the community college level. The program also serves as a foundation for graduate studies continued beyond the M.S. level, especially for those students whose M.S. research experiences are vital to their professional growth and for those who develop strong research interests and abilities. Requirements include 30 units of course work. A thesis or pre-publication manuscript is required.

Doctor of Philosophy: Designed for students who plan to work as professional geoscientists in research-oriented capacities in the academic community, industry, or government. Qualified students with a bachelor's degree or a master's degree may be accepted into the Ph.D. program. Requirements include 36 units of credit in addition to 18 units of dissertation credit. A dissertation is required. A twelve-unit minor is required in a related subject.

The department handles admissions and student advising through six curriculum committees. Students working toward an advanced degree in geosciences should concentrate in one or more of the following areas:

Economic Geology: Ore deposit petrology, especially copper and gold systems; hydrothermal ore deposits; fluid inclusion studies; stable isotope analysis; alteration petrology/geochemistry; plate tectonics and ore deposits; mathematical theory of magma hydrothermal systems; dynamic models of intrusion and fluid movement.

Geophysics: Earthquake and reflection seismology; inverse theory; potential fields; plate dynamics; earth structure; crustal mechanics and evolution; paleomagnetism; feural isostasy and erosional processes.

Mineralogy-Petrology-Geochemistry: Microstructures of minerals; crystal chemistry; experimental mineralogy and petrology; the effects of stress on the kinetics and mechanisms of mineral reactions; thermodynamics and kinetics of the evolution of rocks and minerals; thermal evolution of rocks; crustal genesis; trace element geochemistry; isotope geochemistry; geochronology; geochemistry and petrology of the mantle; geochemistry of hydrothermal processes; organic geochemistry of kerogen, amino acids and the early history of life.

Quaternary Paleoenvironmental Studies: Paleoclimatology; environmental geology; palynology; d/envrochronology; radiocarbon dating; stable isotope geochemistry; quaternary geology-stratigraphy.

Sedimentary-Depositional Environments: Basin analysis; stratigraphy; bioclastic deposition; paleontology; invertebrate and vertebrate paleontology; paleoecology and evolution.
Tectonics: Regional tectonics; tectonic geomorphology; structural geology; sedimentary tectonics; tectonophysics; geotechnique; tectonic implications of paleomagnetism.

In addition there are three interdisciplinary programs:

Archaeological Geology: Quaternary stratigraphy, geomorphology, geologic processes, dating techniques, and environmental reconstructions in relation to the archaeological record. In conjunction with the Department of Anthropology, archaeological method and theory, and modern geoastronomical techniques.

Geohydrology: Geological and geophysical characteristics of aquifers and basins; chemical and isotopic studies of water; mineral-water reactions; remote sensing; aquifer modeling.

Planetary Geology: A concentration through the departments of Geosciences and Planetary Sciences. Geomorphology and cratering of planetary surfaces; geochemical evolution of planetary bodies; geochemistry; cosmochemistry and thermal histories of meteorites; organic geochemistry of the solar system; stress modeling in planetary bodies; planetary geophysics; planetary resources.

500. Introduction to Geochmistry (3) I Nuclear systematics and thermodynamics with applications to geologic processes. P. 101, 103; Chem. 103b, 104b. Ruiz


504. Petrographic Techniques (3) I Introduction to application of modern petrographic techniques. Use of optical theory, optical petrography, electron microprobe and image processing to examine and describe minerals and other materials. 2R, 3L. Anovitz

505. Applied Multispectral Imagery (3) II (Identical with G.En. 505)

507. Photogeology (3) II (Identical with G.En. 507)

508. Mammalian Phylogeny and Evolution (3) II 1992-93 A study of the mammalian fossil record, with emphasis on taxonomy and morphological evolution of selected mammal orders. 2R, 3L. Field trips. Lindsay


510. Principles of Cosmochemistry (3) I (Identical with Pty.S. 510)

514. Late Quaternary Geology (3) I Paleoenvironment and geochronology of Late Quaternary alluvium as read from the stratigraphic records and geomorphology at key localities in North America. The interaction of fluvial and aeolian processes in the eastern Sahara will be evaluated using enhanced LANDSAT and Shuttle Imaging Radar. Domestic field trips. Enrollment limited to 10 students. P. 102, 104. (Identical with Anth. 514) Haynes

515. Advanced Sedimentary Petrology (3) I Advanced study of sedimentary rocks with an emphasis on the recognition of diagenetic features and the application of appropriate techniques to problem solving. Requires a research project in publication format. 1R, 6L. Field trips. P. 451/551. Schreiber

516. Field Studies in Geophysics (3) I II S (Identical with G.En. 516)

517. Sedimentary Basin Analysis (3) II Stratigraphic sedimentological, paleogeographic, and paleoecologic evolution of sedimentary basins with attention to facies relations, depositional systems, and structural and plate tectonic framework. P. 302. Parrish

518. Advanced Mineralogy (3) I 1992-93 Structure and crystal chemistry of minerals, microstructural development, kinetics and mechanisms of mineral reactions and transformations, with application to determining geologic history of rocks. P. 209 or consult department before enrolling. Snow

519. Global Tectonic Processes (3) II Plate tectonics; thermal properties and processes in the Earth; mechanical behavior of lithosphere and mantle; global gravity and geoid. P. Math. 254; Phys. 121. (Identical with Pty.S. 519) Richardson/Chase

520. Meteorites (3) II 1992-93 (Identical with Pty.S. 520)

521. Tectonometamorphism (3) II 1991-92 Introduction to the use of thermodynamics and kinetics in constraining the P-T variables controlling subduction processes. Application of these results to interpretations of regional tectonics and the thermal evolution of planetary bodies. P. consult with department before enrolling. Anovitz

522. Well Logging Interpretation (3) II (Identical with G.En. 522)

523. Regional Structural Geology (3) [Rpt.] I Geologic mapping in a variety of rock types and structural regimes, with emphasis on the recognition and solution of regionally significant structural problems. Field trips. P. 413. Gehrels

524. Paleomagnetism: Principles and Applications (3) II Physical basis for remanent magnetism in rocks, techniques of sample collection, measurements, and statistical treatment; review of polarity time scale, apparent polar wander, plate tectonics. P. Phys. 103b or 116. Butler

525. Regional Tectonics (3) I Discussion of the geology, geophysics, petrology, and geochemistry of different types of orogenic systems and their tectonic evolution. Methods of tectonic regionalization and integration based on lithotectonic assemblages and terranes, and regional structural geology. Plate tectonic regimes and kinematics. Coney

526. Cordilleran Tectonics (3) I Geologic and tectonic evolution of the North American Cordillera based on analysis of geologic, paleomagnetic, and paleobiogeographic constraints and tectonic models. Gehrels

527. Orogenic Systems (3) II An analysis of the geology, geophysics, and geochemistry, and the tectonic evolution of selected world mountain systems ranging from currently active belts in both oceanic and continental settings back through Phanerzoic, Proterozoic, and into Archean time. Coney


529. Scanning Electron Microscopy (1-2) I Introduction to the principles and methods of Scanning Electron Microscopy/Energy Dispersive Spectrometry and Image Analysis for geological/paleontological samples. Students will have the opportunity to conduct original research in SEM/EDS/IA as a portion of the laboratory. 1R, 3L.

530. Chemical Evolution of the Earth (3) I Chemical differentiation and evolution of earth's mantle and crust according to major-element, trace-element and isotopic characteristics of neodymium, hafnium, strontium, lead and other isotopes. (Identical with Pty.S. 530) Patchett

531.* Hydrogeology (3) II (Identical with H.W.R. 531) S. Davis


535. Aquifer Mechanics (3) II (Identical with H.W.R. 535)

536. Development of Groundwater Resources (3) II (Identical with H.W.R. 536)

538.* Biogeography (3) II (Identical with Ecol. 536)


540.* Geodynamics (3) II [Rpt.] Large-scale tectonic problems approached by combined geophysical and geologic analysis in regional context. P. 20 units of geology, including 321, 3 units geophysics, Math. 254; consult with department before enrolling. Chase

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

542. Ore Deposit Petrology (3) II 1992-93 Orthomagmatic, porphyry base metal, skarn, and leached capping lithologic-mineralogic studies by petrographic microscope, electron probe, and advanced techniques. 1R, 6L. P. 425/525 or CR, 646a. Gulbert

543. Mathematical Theory of Magma-Hydrothermal Systems (3) I Dynamics and chronology of natural systems are reconstructed using mathematical systems and computer models to represent the redistribution of thermal and mechanical energy around magma chambers. Morton

544.* Mining Geology (2) I 1991-92 (Identical with G.En. 544)

545. Geochemical Processes in Magma-Hydrothermal Systems (3) I Migration of chemical components in natural fluid-rock sys-
tems are analyzed using the geochemical theory that represents irreversible, equilibrium and advection mass transfer. Norton


54b. Special Topics in Geochemistry (3) I Fundamentals of and practical applications of geophysical techniques. Applications to archeological, geological, and biological dating problems. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam


54d. * Introduction to Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

55. Isotope Geology (3) II Theory and application of light stable isotopes to paleoecological, ore deposition, and geothermal problems. Long 564a-564b.

55a. * Introduction to Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

55b. Isotope Geology (3) II Theory and application of light stable isotopes to paleoecological, ore deposition, and geothermal problems. Long 564a-564b.

56. Botanical Basis of Dendrochronology (3) II Introduction to dendrochronology of trees as a means of paleoecological and paleoclimatic studies. Applications to archeological, geological, and biological dating problems. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

56a. * Introduction to Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

56b. Introduction to Paleoclimatology (3) II Introduction to paleoclimatology of trees as a means of paleoecological and paleoclimatic studies. Applications to archeological, geological, and biological dating problems. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

56c. Advanced Seismology (3) II Advanced seismological techniques in seismology. The application of synthetic seismograms to model source processes and complex structure. P, 432/532; Math. 422b. Wallace

56d. Geophysical Exploration and Engineering (4) I (Identical with G.En. 548)


57. Inverse Problems in Geophysics (3) I Geophysical exploration and engineering (4) I (Identical with G.En. 548)

57a. Introduction to Quaternary Microfossil Analysis (4) [Rpt.1] 1992-93 Literature and techniques of identification of plant remains including leaves, seeds, and wood of gymnosperms and angiosperms. 2R, 6L. Field trips. P, Ecol. 472. O. Davis


58. * Paleoclimatology (3) I 1992-93 Topics in paleoclimatology including prediction of paleoclimatic patterns, proxy paleoclimatic indicators, and paleoclimatic cycles. Parrish

58a. Paleoclimatology in Geosciences (3) I Principles of classical and elementary statistical thermodynamics. Thermodynamic and physical processes; equations of states for solids and gases; solutions; phase equilibrium; nonequilibrium systems with emphasis on geological and planetary problems. P, Math. 125a-125b, or 124, Math. 119 and/or consult with department before enrolling. (Identical with Pty.S. 563)

58b. Design of Exploration Programs (3) II 1991-92 (Identical with G.En. 587)

59. Seminar

a. Petrography-Petrology (1-4) [Rpt.6 units] I I
b. Structural Geology (1-4) [Rpt.6 units] I I

c. * Introduction to Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

59a. * Introduction to Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

59b. * Dendrochronology (3-3) Survey of dendrochronological theory and methods. Applications to archeological, geological, and biological dating problems and evaluation of time-series reconstructions. Emphasis on dating methods, developing tree-ring chronologies, and evaluating tree-ring dates from various contexts. 2R, 3L. Field trips. (Identical with Anth. 544a-544b) Swetnam

59c. * Paleobotany (1-4) [Rpt.6 units] II

59d. * Paleobotany (1-4) [Rpt.6 units] II

59e. * Paleoecology (1-4) [Rpt.6 units] II

59f. * Paleogeochemistry (1-4) [Rpt.6 units] II

59g. * Paleoclimate (1-4) [Rpt.6 units] II

59h. * Paleoecology (1-4) [Rpt.6 units] II

59i. * Paleoecology-Paleoenvironments (1-4) [Rpt.6 units] II

59j. * Paleogeochemistry (1-4) [Rpt.6 units] II

59k. * Paleoecology (1-4) [Rpt.6 units] II

59l. * Paleoecology-Paleoenvironments (1-4) [Rpt.6 units] II

59m. * Paleoecology-Paleoenvironm (1-4) [Rpt.6 units] II

59n. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59o. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59p. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59q. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59r. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59s. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59t. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59u. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59v. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59w. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59x. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59y. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

59z. * Paleoecology-Paleoenvironment (1-4) [Rpt.6 units] II

64. * Principles of Techniques of Hydrothermal Geochemistry (3) II Application of physical chemistry and allied laboratory techniques
German (GER)

Modern Languages Building, Room 571
(602) 621-7385

Professors Louis F. Heibig, Head, David H. Chisholm, Max Dulher (Emeritus), Renate A. Schulz, David J. Woloshin (Emeritus) Associate Professors Dennis I. Greene (Emeritus), Babette Luz (Emerita), Steven D. Martinson, Roland Richter Assistant Professors Albrecht Classen, Barbara Kosta, Kamakshi R. A. Schulz, David J. Woloshin (Emeritus) Chisholm, Max Dufner (Emeritus), Renate Murti, Mary Wildnner-Bassett

The department offers a program leading to the Master of Arts degree with a major in German. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in German. For information concerning this degree, see Requirements for Master’s Degrees/Master of Education elsewhere in this catalog. Courses are available in the various areas of German language, literature, and culture in their more modern and contemporary aspects as well as in earlier historical and linguistic developments. Courses are also available in second language teaching methodology, theory of second language acquisition and testing for a minor option in the M.A. degree in German.

Prerequisite for admission to the graduate program is the completion of at least sixteen acceptable units of upper-division, undergraduate course work in German.

Students working toward the Master of Arts degree must complete a minimum of 32 units of graduate work, including at least 24 units in courses offered by the Department of German. Ger. 601 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 consultation with the departmental Graduate Committee. Students approved for the thesis option must complete the twenty-four hour course work requirement (excluding 910). No more than six units may be earned for writing the thesis; thesis students enroll for Thesis 910.

The student must pass both a written and an oral comprehensive examination. Prior to this examination each student must either have passed 575a or 575b successfully or give evidence of an equivalent proficiency in the use of written German and must rate Superior on the ACTFL/ETS Oral Interview Test or an equivalent test.

500. Intensive Reading German for the Sciences and Humanities (4 hrs/wk., no credit) $ Rapid acquisition of reading proficiency in German. No prior knowledge of German is necessary. Proficiency certification obtained from this course fulfills graduate foreign language requirement in some departments (consult department for information).

501. German Lyric Verse from the Reformation through Classicism (3) II 1992-93 Introduction to the principles and forms of poetry; analysis and interpretation of outstanding examples of German lyric verse from the 16th through the 18th centuries. P. 6 units of upper-division German.

502. German Lyric Verse from Romanticism to the Present (3) I 1991-92 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.

503. Eighteenth-Century German Literature (3) II 1991-92 Klopstock, Lessing, Wieland, Goethe, Schiller, Hoelderlin and other authors. P. 6 units of upper-division German.

504. German Romanticism and Realism (3) I 1992-93 Readings and discussions of representative works from 1797 to 1848. P. 6 units of upper-division German.

505.* History of the English Language (3) I (Identical with Engl. 505)

506. German Literature from 1848 through Naturalism (3) I 1991-92 Readings of major prose and dramatic works of the second half of the 19th century, in German. P. 6 units of upper-division German.

507. Goethe’s Faust (3) II 1992-93 A close reading of the poem and an introduction to some of the critical secondary literature. P. 6 units of upper-division German.

509. German Literature from 1900 through the Weimar Republic (3) II 1991-92 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 1992-93 Readings of major prose and dramatic works after 1933, in German. P. 6 units of upper-division German.

511. Middle High German (3) II 1992-93 Introduction to Middle High German language and literature; selective readings from representative literary works of the period. P. 302b, 315b.

520. History of the German Language (3) II 1991-92 Introduction to Germanic philology; an overview of the development of the German language from its roots in the Indo-European language family to New High German. P. 6 units of upper-division German. (Identical with Engl. 520)

525. Beowulf (3) II (Identical with Engl. 525, which is home)

527a. Studies in Medieval Language and Literature (3) (Identical with Engl. 527a)

555.* Music and German Literature (3) I 1992-93 The interrelationship between music and German literature from the 18th through the 20th centuries. Concentrates on major works of German drama, poetry and prose, and their musical settings. Lectures in English. Readings primarily in English, some German. P. 202. (Identical with Mus. 555)

575a-575b.* Advanced Grammar and Stylistics (3-3) Practical training in written German through the study of the more complex refinements of German grammar and style, as found in representative documents. P. 315b. 575a is not prerequisite to 575b.

579.* Issues in Foreign Language Teaching (3) I Modern methods of language teaching with emphasis on German as a foreign language.

580.* Applied Linguistics for Foreign Language Teaching (3) II Issues in and methods of applied linguistics with emphasis on German languages.

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, Clás. 585, Ling. 585, Russ. 585, and Span. 585)

594. Practicum
a. Literature (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

b. Pedagogy (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

c. Culture (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

d. Linguistics (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

e. Translation (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

596. Seminar
a. Literature (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.

b. Pedagogy (1-5) [Rpt./5 units] I II P. competency at fourth-year undergraduate level or pass departmental placement examination.
ences. A minimum of fifteen units selected from required and elective courses is required. It is
an interdisciplinary major that incorporates faculty from nine departments and five colleges within the University.

All applicants must submit scores in the General Test of the Graduate Record Examination, a statement of professional goals, and three letters of recommendation from persons in a position to evaluate the applicant's potential as a graduate student.

The purpose of these graduate programs is to prepare individuals for careers in exercise science, health science, research and teaching. Recognizing that most students wish to specialize in their graduate work, it is necessary to insure some breadth of knowledge is obtained in the exercise, health, and sport sciences. Students are permitted to use graduate or undergraduate courses for satisfaction of any perceived deficiencies.

Community and Environmental Health
1435 N. Fremont Ave., Room 111
(602) 862-5852

Associate Professors Richard L. Papenfuss, Head, Kam Nasser
Assistant Professors Clifton D. Crutchfield, Mark D. Van Ert

At the time this catalog was being edited, the Master of Education degree with a major in health education was being redesignated. All current and prospective students should check with the Division of Community and Environmental Health for current admission and degree requirements in this major.

Occupational Safety and Health (OSH)

502. Industrial Hygiene Instrumentation and Analysis (2-4) I Introduction to field sampling instruments and strategies, quality control, and statistical analysis, with emphasis on instrument selection and calibration. 2R, 3L. P: 586. (Identical with Tox. 502)

510. Physical Exposures (3) II Recognition, evaluation, and control of physical exposures, including radiation, noise, vibration, and heat stress. Student is required to recognize potential exposures, use correct instrumentation to collect and evaluate data, and develop controls. 2R, 3L. P: 486. (Identical with Tox. 510)

512. Hazardous Materials (2-4) I Recognition, evaluation, and control of exposure to en-
environmental and industrial air contaminants. P. 586. (Identical with Tox. 512)

561.* Accident Prevention (2) (Identical with Mn. E. 561)

586.* Fundamentals of Industrial Hygiene (3) I Introduction to the principles of occupational safety and health, with emphasis on industrial hygiene aspects including recognition, evaluation, and control of environmental and industrial health hazards. (Identical with C. E. 586, G. En. 586, Mn. E. 586, and Tox. 586)

587.* Advanced Industrial Hygiene and Safety (3) I If in-depth coverage of the industrial hygiene and safety professions emphasizing the principles of contaminant behavior and the design of industrial hygiene/safety programs. P. 486. (Identical with C. E. 587 and Tox. 587)

*May be converted with 400-level course.

Exercise and Sport Sciences (EXSS)

Ina E. Gittings Building, Room 101 (602) 621-6989


Study programs for both the Master of Arts and Master of Science degrees are individually planned, in consultation with an advisor, around a principal area of interest. The Department of Exercise and Sport Sciences offers two options for the major, one that is clinical in nature and the other that is thematic (individualized). Clinical exercise science includes three specializations: athletic training, stress management and wellness, and sports and activities. The thematic option permits students to develop a study plan that builds on the student's background, special interests and future goals. In consultation with an advisor, students are able to develop a program that may encompass the more traditional areas of study or they can develop totally new ones.

Students should have an undergraduate academic background which supports their interest area(s) at the graduate level. For example, some specializations/study plans require an undergraduate science background that includes anatomy, physiology, chemistry, and similar subjects, while others do not.

Master's degree candidates may select one of three plans: (1) a thesis option which requires 30 units including preparation of a thesis for which 6 units may be earned, or (2) a non-thesis option which requires completion of 32 to 36 units, depending on the program of study, and a comprehensive written exam, (3) a research project option, which requires completion of 32 to 36 units, depending on the program of study, and preparation of a manuscript for publication and presentation of findings in a seminar in lieu of the comprehensive written exam.

For all plans, at least 20 units must be completed in the Department of Exercise and Sport Sciences, but students are encouraged to take work in fields outside the department if it is relevant to their course of study.

Professional Preparation Courses

502. Principles of Neuroanatomy (4) II (Identical with Anat. 502)

510. Sport in Contemporary Society (3) I Study of contemporary sport from the perspectives of its personal, social, cultural, economic and educational dimensions. Russell

520.* Exercise Physiology (3) I Regulation and adjustment of physiological systems during acute exercise and adaptations with chronic exercise in various populations and environments; emphasizes physiological mechanisms. P. Chem. 103a-103b, 104a-104b, Ecol. 159a-159b, 160a-160b, Math. 117R/S, 118. Fregosi

521.* Exercise Physiology Laboratory (1) II P, CR, 520.

525. Motor Learning and Human Performance (3) I Neuropsychological approach to the study of motor skill acquisition and learning variables affecting human potential for physical performance. Fairchild

527. Psychology of Sport and Exercise (3) I Examines the effects of motivation, personality, attitudes, competition and group dynamics on sport performance as well as the psychological effects of exercise, exercise adherence and exercise addiction. Williams

528. Stress Management for Performance and Health (3) I Examines within a biopsychosocial framework the concept of stress as it relates to performance and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams

529. Psychological Interventions and Ergogenic Aids for Peak Performance (3) II The application and effectiveness of ergogenic aids mechanisms, particularly psychological interventions, in enhancing performance. P. 528. Williams

530. Advanced Physiology of Exercise (4) I Metabolic, cardiopulmonary, thermoregulatory, fluid-electrolyte, neuroendocrine, neuromuscular and various environmental factors which influence physiological adjustments to acute exercise and the physiological adaptations to chronic exercise. P. 373 or 420/520. Tipton/Enoka/Fregosi/Henriksen/Kregel/Lohman/Seals

536. Administration of Sports Programs (3) I Designed to provide a theoretical framework for students pursuing sports management careers and others interested in various functions involved in the conduct of sport programs. Baker

545. Evaluation and Regulation of Body Build and Composition (3) I Laboratory and field assessment of body fat, lean body mass and somatotype; anthropometry; body build and composition of the athlete; morphology of fat and lean tissue; exercise and dietary regulation of obesity and chronic underweight. P. 373 and 374, or 420/520 and 421/521; Math. 117R/S. Lohman

550. Advanced Exercise Physiology Laboratory (3) I Experiments designed to demonstrate basic concepts of physiological responses to exercise with emphasis on development of skills in laboratory instrumentation and techniques of research. P. 530. Roby/Enoka/Fregosi/Henriksen/Kregel/Lohman/Seals

560.* Biomechanics of Human Movement (3) II Analysis of human motion focusing on the mechanical interaction between the human body and the external environment. 2R, 3L, P. 362 or 462, Ecol. 159a-159b, 160a-160b. Atwater/Enoka

562.* Neuromechanical Kinesiology (3) I II Neuromechanical bases of human movement. P. Ecol. 159a-159b, Math. 118. Enoka


566. Physical Activity in Aging and Chronic Diseases: Psychosocial Aspects (3) I Psychosocial dimensions of exercise programs designed for populations with chronic diseases as well as for older populations. P. 565. Fairchild

567. Research Design in Exercise and Sport Sciences (2) I Study of research design methods and data analysis procedures pertinent to the exercise and sport sciences; emphasis is on the selection of research problems and interpretation of research articles. Lohman

571. Laboratory in Research Design for Exercise and Sport Sciences (1) II Laboratory experiences in literature retrieval systems; data analysis procedures by calculator, microcomputer, and mainframe computer; critical analysis procedures of research articles, and participation in a research project. CR 570. Lohman

575. 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 appropriateness of selected designs and interpretation of various data analysis procedures. Statistical power, reliability, covariance and multiple regression techniques and uses of micro- and mainframe data analysis software. P. 570 and 571. Lohman

580. Evaluation of Athletic Injuries (3) I Advanced study of the etiology, pathology, and clinical signs of common athletic injuries. Emphasis on clinical evaluation of athletic injuries by the athletic trainer. P. 377; 800 hrs. of clinical experience in athletic training. Delforge

581. Therapeutic Modalities (2) II Advanced study of the role of hydrotherapeutic and electrotherapeutic agents in the rehabilitation of athletic injuries. P. 580. Delforge

582. Anatomical Basis of Sport Injuries (3) I Comprehensive survey of bones, ligaments, muscles, tendons, and vessels of the trunk and upper and lower extremities, with emphasis on their relationship to sport injuries. 2R, 3L, P. CR 580. Hillman
583. Medical Aspects of Sports Injuries (3) II Common surgical procedures and post-surgical immobilization techniques used in the management of sports-related injuries; implications for post-surgical therapeutic exercise programs. P. 580, 582. Hillman

584. Rehabilitation of Athletic Injuries (3) II Principles in the planning and implementation of rehabilitation programs for injured athletes with emphasis on application of contemporary therapeutic exercise techniques. P. 580. Delforge

585. Issues in Athletic Training and Sports Medicine (3) II Current issues and trends in athletic training and sports medicine with emphasis on the professional preparation of athletic trainers and the role of the certified athletic trainer in athletic health care delivery systems. P. 580. Delforge

586. Physical Education and the Law (3) II Investigation and analysis of legal parameters within which the physical educator and coach operate; negligence theory; common defenses; product liability; insurance; legal implications for program development and methodology. Baker

587. 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
a. Cardiac Rehabilitation (2) II S 1R, 7L, P. 530, CPR certification.
b. Adult Fitness (2) II S 1R, 7L, P. 530, CPR certification.

593. Internship
b. Sport Psychology (1-3) [Rpt/6 units] II S 526 or 529.

595. Colloquium
b. Biomechanics (2) [Rpt/4 units] P. 460 or 462.

596. Seminar
b.** Analysis of Data in Exercise and Sport Sciences (1) II Atwater

597. Research
a. Laboratory Rotations (1-3) II S 3-9L Open to majors only. P. 570, 571.

695. Colloquium
a. Motor Control (2) [Rpt/6 units] P. Pso. 480 and consult department before enrolling. (Identical with Pso. 695a, Pysc. 695a, SpH. 695a, S.I.E. 695a)

793. Internship
a. Sport Psychology (1-3) [Rpt/12 units] II S 526 or 529.

Medical Technology (MEDT)

1435 N. Fremont Avenue, Room 124 (602) 626-4084

Associated Professors B. Sue Criswell, Director Assistant Professors Harold L. Potter, Jr., JoAnn Thomas, JoAnn Willson.

Although no graduate degree programs are offered by the Division of Medical Technology, the graduate courses listed below are available to graduate students enrolled in related programs such as microbiology and chemistry.

571R.* Lectures in Clinical Hematology (3) [Rpt/1] II Basic laboratory techniques in clinical hematology; emphasis on manual and automated hemostatic procedures, interpretation of laboratory test results. P. CR, 471R/571R, consult committee before enrolling.

571L.* Fundamental Laboratory Techniques in Clinical Hematology (2) [Rpt/1] II Basic laboratory techniques in clinical hematology; emphasis on manual and automated hemostatic procedures, interpretation of laboratory test results. P. CR, 471R/571R, consult committee before enrolling.

572R.* Lectures in Clinical Immunology and Immunohematology (3) [Rpt/1] II Lectures in serological methods used in the clinical laboratory and interpretation of results; blood banking procedures. P. consult committee before enrolling.

572L.* Fundamental Laboratory Techniques in Clinical Immunology and Immunohematology (1) [Rpt/1] II Basic laboratory techniques in serological procedures and blood banking. Emphasis will be placed on procedural methodologies, quality control, the use of controls and standards, and interpretation of laboratory test results. P. CR, 472R/572R, consult committee before enrolling.

573R.* Lectures in Clinical Chemistry (5) [Rpt/1] II Lectures encompassing the fundamental concepts of clinical laboratory chemistry including pathophysiology and clinical correlations. P. consult committee before enrolling.

573L.* Fundamental Laboratory Techniques in Clinical Chemistry (1) [Rpt/1] II Basic laboratory techniques in clinical chemistry. Emphasis will be placed on procedural methodologies, quality control, the use of controls and standards, and interpretation of laboratory test results. P. CR, 473R/573R, consult committee before enrolling.

574R.* Lectures in Clinical Bacteriology (4) [Rpt/1] II Lectures relating to laboratory techniques used to safely isolate and identify pathogenic bacteria. Special media/tests, organismal virulence factors, pathologic effects occurring within the host and antibiotic susceptibility testing of bacteria are covered. P. consult committee before enrolling.

574L.* Fundamental Laboratory Techniques in Clinical Bacteriology (1) [Rpt/1] II Basic laboratory techniques used in the isolation and identification of bacteria pathogenic for humans. Standard and specialized media/biochemical tests are utilized. P. CR, 474R/574R, consult committee before enrolling.

575a-575b-575c.* Topics in Clinical Microbiology (2-11) [Rpt/1] II S 575a: Clinical Parasitology. Diagnostic methodologies with emphasis on the laboratory identification of clinically relevant fungi and Mycobacterium sp. P. consult committee before enrolling.

576.* Principles of Laboratory Science (3) [Rpt/1] II Basic principles of laboratory mathematics, biostatistics, body fluids analysis, urinalysis, quality control and laboratory safety. P. consult committee before enrolling.


May be convened with 400-level course.

Higher Education
(See Educational Foundations and Administration)

History (HIST)

Social Sciences Building, Room 215 (602) 621-1586

Professors Michael Schaller, Head, Herman E. Batesman (Emeritus), Gail Bernstein, Robert P. Browder (Emeritus), Paul A. Carter, Richard A. Cosgrove, Leonard Dinnerstein, James Donohue (Emeritus), Harwood Hinton (Emeritus), Ursula Lamb (Emerita), Oscar Martinez, John V. Mering, Michael C. Meyer, Roger L. Nichols, Heiko A. Oberman, J. Gregory Oswald (Emeritus), Thomas W. Parker (Emeritus), Boyd Staver (Emeritus), 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 with a major in history or related subject and are required to submit scores on the aptitude tests of the Graduate Record Examination, a statement of purpose, and three letters of recommendation. All Ph.D. students must participate in a formal review of their program during the first year of doctoral studies.

Degrees

Master of Arts: At least 24 units must be completed in history including 21 units in one of the following areas: Ancient Europe, 800-1648; Europe, since 1648; Latin America; United States; Asian History. The student who elects to submit a thesis for six units will receive thesis credit for six units and will be required to complete at least twelve additional units at the 595-596 level in history. The student who elects to present two research seminar papers (six units) in lieu of a thesis is required to complete at least eighteen units at the 595-596 level in history. Each student must demonstrate reading knowledge of one foreign language. In special cases computer programming or statistics may be substituted for the foreign language requirement. Each student must pass a final examination covering one of the two areas selected for concentration. A total of 30 units is required for the degree.

Master of Education: All students must complete at least eighteen units in history, not fewer than six of which are at the 595-596 level or above. An oral or written examination covering the work in history as well as an examination by the College of Education must be passed, but no thesis is required. For further information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Doctor of Philosophy: In consultation with an advisor, each beginning student will select primary and secondary areas of concentration within the history major. Each student must demonstrate a reading knowledge of two foreign languages. In United States history, a reading knowledge of one foreign language and possibly other skills will be required. Preliminary to admission to formal candidacy, each student must pass an examination covering the fields chosen. Following this examination, the candidate must prepare and defend a dissertation displaying mature research in original sources, competence in assembling and presenting historical data, and critical scholarship. Primary areas of concentration: ancient history; Europe, 800-1648; Europe, since 1648; Latin America; United States. Secondary areas of concentration: Any primary area of concentration other than the chosen one; an approved minor in another department; or Asian history; comparative women's history; history of religion.

501.* Ancient Mesopotamia (3) I (Identical with Anth. 501)
504a-504b.* History of Rome (3-3) 504a: The Republic to the death of Caesar. 504b: The Empire through the reign of Constantine the Great. 504a is not prerequisite to 504b.
505a-505b.* Medieval Europe (3-3) Major institutions and trends in Europe from the breakup of the Roman World to the 14th century. 505a is not prerequisite to 505b. P: 3 units of lower-division European history.
506.* Medieval England (3) II From the Norman conquest to the Hundred Years War, with emphasis on political, social, and cultural developments. P: 3 units of lower-division European history.
507a-507b.* Intellectual History of Medieval Europe (3-3) Major medieval cultural and intellectual trends. 507a: High Medieval Europe. Emphasis on the period before 1300. 507b: Late Medieval/Early Modern Europe. Emphasis on the period after 1300. P: 3 units of European history. 507a is not prerequisite to 507b.
508.* The Renaissance (3) I Europe between the 14th and 16th centuries with special emphasis on Italy as the seat of the Renaissance. Topics include the city states, humanism, the Church in an age of Schism and secularization, Renaissance art, the New Monarchies and European exploration and imperialism. P: 3 units of European history.
509.* The Reformation (3) II The Reformation in thought and action both from the perspective of its religious origins and of the political and social conditions. Analysis of its impact on sixteenth century Europe including the spread of Protestant reformation and its companion movement, counter-reformation.
510.* History of Hell in Early Europe (3) II The concept of punishment after death in Western Europe from the Bible to Dante. Includes the Hebrew, Greco-Roman, Germanic, and Christian traditions. P: 3 units of European history.
511.* European Social and Intellectual History to 1750 (3) I Dominant themes in European intellectual history from the end of the Middle Ages to the period of the Enlightenment. Reading and discussions of texts from Petrarch to Locke. P: 3 units of any history course.
512.* European Intellectual History: 1750 to 20th Century (3) II Dominant themes in European intellectual history from about 1750 to the 20th century. Reading and discussions of texts from David Hume to Friedrich Nietzsche. P: 3 units of any history course.
513.* War and Peace in Europe (3) II European background to contemporary international relations from the Congress of Vienna through the outbreak of World War II.
514.* Cultural History of Germany to 1714 (3) I The political, social, economic and cultural history of Germany from the late Middle Ages to about 1800. P: 3 units of any history course.
515.* Cultural History of Germany 1714 to 1899 (3) II The political, social, economic and cultural history of Germany from the period of the French Revolution to the present. P: 3 units of any history course.
516.* Tudor-Stuart England (3) I An intensive study of English history from the accession of Edward IV to the Hanoverian dynasty.
517.* History of Modern Britain (3) II An intensive study of English history from the accession of George III to the present.
518.* France under the Old Regime, 1569-1789 (3) I French political development, institutions, and culture from Henry IV to the eve of the French Revolution.
519.* The French Enlightenment (3) I Cultural history of France in the 18th century, with emphasis on the works of the philosophes.
520.* The French Revolution and Napoleon (3) II The origins and progress of the Revolution in France.
521.* History of Russia: Early Period (3) I Political, socio-economic, and cultural history of Russia in medieval and early modern times.
522.* History of Russia: Modern Period (3) II Political, socio-economic, and cultural history of Russia in the modern era until the Bolshevik Revolution.
523.* Intellectual History of Russia (3) II The historical significance of social, political, and revolutionary thought in 19th- and 20th-century Russia. P: 3 units of any history course.
524.* The Russian Revolutions (3) I The era of reform and revolutions in Russia from 1890 to 1921, culminating in the formation of the Soviet regime. P: 3 units of any history course.
525.* History of the Soviet Union (3) I The Bolshevik Revolution and problems of Soviet Russian history from 1917 to the present. P: 3 units of any history course.
531.* Colonial America (3) I The experience and evolving institutions of the North Atlantic colonists from the first landings to the end of the French and Indian War. P: 3 units of any U.S. history survey course.
532.* The Era of the American Revolution (3) II Origins, progress, and character of the struggle against Great Britain; internal political, constitutional, social, and economic developments; the problems of the "Critical Period" and the making of the Constitution. P: 3 units of any U.S. history survey course.
533.* Jefferson and the New Nation, ca. 1790-1828 (3) I Major ideological, political, economic, and social conflicts and developments, North and South, during the first decades of the American nation. P: 3 units of any U.S. history course.
534.* Jacksonian Era, 1828-1856 (3) I II Political, economic and social developments from the "reign" of Andrew Jackson through the collapse of the Whig Party in the 1850s. P: 3 units of any U.S. history course.
535.* The Coming of the Civil War, U.S. 1845-1861 (3) I Political, constitutional, social and economic developments in the U.S. from the Mexican War through the Civil War.
536.* Civil War and Reconstruction, U.S. 1861-1878 (3) II Political, constitutional, economic, and military developments in the U.S. and the Confederacy during and after the Civil War.
537.* U.S. 1876-1919 The Gilded Age and Progressive Era (3) Examination of economic, so-
cial and political developments in years of rapid industrialization from the end of Reconstruction through World War I. P. 3 units of any history course.

538.* U.S. 1918-1945 From World War I through World War II (3) Prosperity, Depression and the New Deal in peace and war.

540.* United States: 1945 to Present (3) I American society and the role of the United States in world affairs from the Yalta Conference to the present. P. 3 units of any history course.

542.* History of American Society and Thought: Pre-Civil War (3) I American political, religious, cultural and philosophical ideas as expressed in colonial, revolutionary, and pre-Civil War society.

543.* History of American Society and Thought Since the Civil War (3) II The transformation of American minds since the Civil War as expressed in literary, philosophical, religious, and other cultural forms.

545.* History of Arizona (3) III Economic, social, and political development of the state from Spanish times to present.

549.* History of American Foreign Relations to 1914 (3) I Examines the rise of America from a struggling colony to a world class power, including its relations with Europe, Latin America and Asia. P. 3 units of any history course.

550.* History of American Foreign Relations Since 1914 (3) II Examines the pivotal role played by the United States in world affairs since WWII, focusing on America's struggle with revolutionary movements in Europe, Asia and Latin America. P. 3 units of any history course.

551.* The United States and East Asia: 1840 to the Present (3) III An examination of American interaction with Japan and China since the Opium Wars, with special attention given to economic, cultural, and military relations and conflicts. P. 3 units of any history course. (Identical with L.A.S. 551)

552.* American Ethnic History (3) II A history of the various ethnic minorities in America from Colonial times to the present, with emphasis on adjustment, acculturation and degrees of assimilation. P. 3 units of any history course.

553.* History of Women and Work (3) I History of women and work in western and non-western nations from prehistoric times to the present. P. 3 units of any history or women's studies course.

555.* Central America: From Colonialism to Revolution (3) II Social, economic, and political history of Central America from colonial period to the present focusing on the origins of contemporary crisis. (Identical with L.A.S. 555)

557.* The Mexican Revolution (3) S A detailed examination of Mexico's social upheaval of 1910, and its implications for contemporary Mexican society. Offered in Guadalajara only.

558.* Feminism: A Comparative History (3) II International history of feminism as an ideology and a political movement from the 17th century to the present. P. 3 units of any history or women's studies course.

559. History of Books and Printing (3) I (Identical with L.S. 559)

562.* Intellectual History of Latin America Since 1810 (3) II Latin American thought from Independence to the 20th century; major Latin American thinkers and writers, and influences from Europe and the United States.

563.* Asian Marxism (3) II (Identical with E.A.S. 563)

564.* History of Argentina (3) I Survey of Argentine history and culture from the colonial era to the present. P. 3 units of any lower-division Latin American history course. (Identical with L.A.S. 564)

565.* History of Spain (3) I II S History of Spain from remote times to the present; emphasis on the period from 1492, Spain's role in the world and the Spanish Civil War; Spain's cultural contributions.

566.* History of Brazil (3) II History of Brazil from 1500 to the present. (Identical with L.A.S. 566)

567.* Contemporary Latin America (3) I Revolution, social change and reaction in Latin America from 1930 to the present. (Identical with L.A.S. 567)

568a-568b.* Asia and the West (3-3) 1991-92 Processes of interaction between Europeans and the peoples and cultures of the Middle East, South Asia, and East Asia, from the Portuguese explorations to the present. (Identical with N.E.S. 568a-568b)

569.* History of Women In Latin America (3) II Women's history in Latin America from the Conquest to the present. P. 3 units of any lower-division Latin American history or women's studies course. (Identical with L.A.S. 569)

570.* Religious History of India (3) Development of major religious traditions of South Asia: Vedic Religion, Buddhism, Jainism, Hinduism, Sikhism, and Islam. (Identical with N.E.S. 570)

572.* History of Medieval India (3) I Survey of Indian history from the 7th century to 1750. (Identical with N.E.S. 572)

573.* History of Modern India and Pakistan: 1750-1950 (3) II Survey of political, social and economic developments in South Asia from the mid-18th century to the present. (Identical with N.E.S. 573)

574a-574b-574c.* History of Japan (3-3-3) Social, cultural, economic and political history of Japan. 574a: From earliest times to 1500. 574b: 1500-1800. 574c: 1800-present. (Identical with Jpn. 574a-574b-574c). P. 3 units of any history course.

575.* History of Byzantium (3) II Political, social, and cultural history of Byzantium from A.D. 330 to 1453, including the Byzantine legacy in Europe and the Middle East. (Identical with Clas. 575)

576.* Women in East Asia (3) I Women in traditional China and Japan; analysis of changes occurring in the modern period. (Identical with E.A.S. 576)

579.* History of Books and Printing (3) I (Identical with L.S. 559)

582.* Social History of China (3) (Identical with Chn. 582)

588.* History of Byzantium (3) II Political, social, and cultural history of Byzantium from A.D. 325 to 1453, including the Byzantine legacy in Europe and the Middle East. (Identical with Clas. 588)

590.* Philosophy of History (3) I Introduction to historical thinking from antiquity to the present, with emphasis on ideas in European and North American historical writings during the modern and contemporary eras.

592.* History of Sufism (3) II Origin and development of Sufism and its impact on the Muslim and non-Muslim worlds. (Identical with N.E.S. 592)

595. Colloquium Certain colloquia in other departments may be used for history graduate credit.

a. Advanced Studies in United States History (3) [Rpt./10] I II

b. Advanced Studies in Latin American History (3) [Rpt./10] I II (Identical with L.A.S. 595b)
c. Advanced Studies in European History (3) [Rpt./10] I II
d.* Latin American Studies Special Topics (3) [Rpt./1] (Identical with L.A.S. 595d, which is home)
e. Advanced Studies in the History of Women (3) [Rpt./10] I II (Identical with W.S. 595e)
f. Advanced Studies in Ancient History (3) [Rpt./10] I II Consult department before enrolling. (Identical with Clas. 595f)
g. * Chinese History Since 1949 (3) I II (Identical with Chn. 595r, which is home)

*May be convened with 400-level course.

596. Seminar Certain seminars in other departments may be used for history graduate credit.

a. Colonial U.S. History (3) [Rpt./10] I II

b. Nineteenth-Century U. S. History (3) [Rpt./10] I II
c. Twentieth-Century U. S. History (3) [Rpt./10] I II

d. Ancient History (3) [Rpt./10] I II

e. Medieval Europe (3) [Rpt./10] I II

f. Early Modern Europe (3) [Rpt./10] I II. P. Latin and German required.

g. Nineteenth-Century Europe (3) [Rpt./10] I II

h. Twentieth-Century Europe (3) [Rpt./10] I II

i. Colonial Latin America (3) [Rpt./10] I II (Identical with L.A.S. 596i)

j. Latin America: Modern Period (3) [Rpt./10] I II (Identical with L.A.S. 596j)
k. Historical Writing and Editing (3) [Rpt./10] I II

l. Mexican-American Heritage Bibliography — A Library Seminar (3) [Rpt./10] I
History and Philosophy of Science (HPSC)

Social Sciences Building, Room 213
(602) 621-3120

Committee on History and Philosophy of Science (Graduate)

Professors Henry C. Byerly (Philosophy), Chair, Robert M. Harmish (Philosophy and Linguistics), William A. Longacre (Anthropology), Richard E. Michod (Ecology and Evolutionary Biology)

History of science deals with the origins and development of science as an activity which seeks understanding of our universe. Philosophy of science deals with the logical analysis of scientific reasoning, the clarification of fundamental scientific concepts, and methodological problems common to many fields of scientific inquiry.

The committee offers a Doctor of Philosophy minor in history and philosophy of science. Its interdisciplinary nature makes it useful as a supplement to the doctoral work of students in the sciences who are interested in foundational or methodological issues, as well as to students of philosophy or history.

Home Economics

(See Family and Consumer Resources)

Hydrology and Water Resources (HWR)

Geology Building, Room 122
(602) 621-5082

Professors Daniel D. Evans, Acting Head, Nathan Burns, Donald R. Davis, Stanley N. Davis (Geosciences), Robert E. Dickinson (Atmospheric Physics, Tree Ring Lab), Lucien Duckstein (Systems and Industrial Engineering), Martha W. Gilliland, John W. Harshbarger (Emeritus), Richard H. Hawkins (Watershed Management), Simon Ince (Civil Engineering), Austin Long (Geosciences), William B. Lord, Thomas Madison Ill, Shilomo P. Neuman, Eugene S. Simpson (Emeritus), Ernest T. Smoren (Civil Engineering), Sorosh Sorooshian (Civil Engineering), D. Davis/Duckstein, Neuman

Associate Professors Roger C. Bales, Randy L. Bassett, Michael D. Bradley

Assistant Professors Martha H. Conklin, Dana Entekhabi, Michael J. Sully, 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, hydrodynamics / hydroclimatology, environmental hydrology, ground-water hydrology, surface-water hydrology, mathematical and statistical methods in hydrology (including numerical modeling), and in water resource planning, management, and administration.

Applicants need not have completed an undergraduate major in hydrology; however, previous study in a closely related field is prerequisite. The programs have been developed to enable graduates from the basic sciences and from related fields such as geology, engineering, agriculture, meteorology, economics, and political science to enter directly. Applicants should submit Gradate Record Examination scores (general test only), a statement of purpose or career objective, and three letters of recommendation.

Graduate study programs are individually planned to meet the student's special interests and professional objectives. Certain basic courses in hydrology and water resources are required of each master's candidate unless equivalent courses were taken elsewhere. A thesis based on individual research is required for the master's degree, and all students are expected to acquire a capability for computer programming.

Applicants for admission to the Doctor of Philosophy degree program should have completed the Master of Science degree with a major in hydrology, water resources, environmental sciences, environmental engineering, or a related field. Where gaps exist in background knowledge of relevant subject matter, the student may be required to take additional course work.

Hydrology: The program is designed for students with special interest in the physical, chemical, and biological aspects of the hydrologic cycle as it relates to water resources. Students may concentrate in one or in a combination of these fields but should acquire some proficiency in all aspects of hydrology and water resources administration.

Water Resources Administration: This interdisciplinary program is for students with special interests in operations research, management, environmental studies, or the social sciences as related to water resources. Students majoring in the program are expected to have or acquire a basic knowledge in hydrology. Three areas of concentration are currently defined: water policy and planning, water resources systems, and environmental water quality management.

500. Ecosystematology for Urban Planning (3) I Introduction to conceptual tools used in complex ecosystems, particularly cities and urban areas; integration of human residents with larger natural systems (human ecology); environmental impact assessment (EIA) and statement (EIS); water resource planning and impact on regional ecosystems; technical, legal, ethical dimensions of water transfer. (Identical with PIng. 500) Bradley

503. Subsurface Fluid Dynamics (3) I Dynamics of fluids in porous and fractured media, with emphasis on heterogeneity, anisotropy, and scaling issues. P, A.M.E. 331a or C.E. 321. (Identical with C.E. 503) Neuman

504. Numerical Methods in Subsurface Hydrology (4) II Finite difference, finite element and boundary integral methods for subsurface fluid flow and mass transport; applications to aquifers, unsaturated soils, seepage through earth structures. P, Math. 422a or consult department before enrolling. (Identical with C.E. 504) Neuman


506. Water Quality Dynamics (3) II Chemical and physical methods are used to study the quality of ground and surface waters with emphasis on organic contaminants, colloids, and surface processes including sorption phenomena. Equilibrium and dynamic models of water chemistry. P, 517R-517L. Sully

507.* Hydrology of Unsaturated Media (3) I Physical properties and the transport of mass and energy in unsaturated porous media. P, Phys. 116, Math. 125b. (Identical with S.W. 507) Sully

508.* Vadose Zone Monitoring (2) II 1992-93 Laboratory and field methods for characterizing water flow and contaminant transport through unsaturated geologic media. P, 507 or 518. Sully


514a-514b.* Field Hydrology (Summer Camp) (3-3) S Field methods of collection, compilation, and interpretation of data in surface and ground-water hydrology; investigation of a small water resources project; preparation of hydrologic reports. Daily field work. Fees. P, 518, 519, Ince/Sully

515.* Introduction to Water Resources Policy (3) II Water resources policy including the identification of regional problems of water use, the elements of water planning, water rights, and a consideration of institutional structures and processes. P, Math. 125a. (Identical with Geog. 515) Bradley


517R. 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. Open to majors only. 517R may be taken in conjunction with or independent of 517L; however, prerequisite to 517L. P, Chem. 103b, Phys. 116, and Math. 125b; CR, Math. 254. Bales/Bassett/Conklin

517L. Fundamentals of Water Quality Laboratory (1) I Experiments in water quality analysis. SL, P, CR. 517R. Bales/Bassett/Conklin
518. Subsurface Hydrology (3) I Physical, mathematical, geologic, and engineering fundamentals to subsurface hydrologic processes. Open to majors only, P, CR, A.M.E. 331a or C.E. 321; Math. 254; P, Geos. 101. S. Davis/Maddock/Sully

519. Surface Water Hydrology (3) II Survey of main topics in surface water hydrology: hydro-meteorology, evaporation, rainfall-runoff, statistical and probabilistic methods, unit hydrograph method, and flood routing. Open to majors only, or consult department before enrolling. CR, C.E. 321, Stat. 361. Ince/Entekhabi/D. Davis

520. Water Resources Management, Planning, 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 resources planning, institutional and organizational arrangements, and policy processes such as adjudication and rule-making. Open to majors only. Bradley/Barrett


522. Well Logging Interpretation (3) II (Identical with G.E. 522)

523.* Hydrology (3) I (Identical with C.E. 523)

524. Hydroclimatology (3) I Precipitation formation processes, the surface and atmospheric branch of the hydrologic cycle, land surface-atmosphere interaction, surface energy balance, evapotranspiration, heat and moisture fluxes into the soil. P, consult department before enrolling

525. Water Quality Modeling (3) I (Identical with C.E. 525)

526. Water Quality Management (3) II Optimization and systems analysis techniques used in modeling current models used in formulation and implementation of water quality policy. P, 525. (Identical with C.E. 526) Buras

531.* Hydrogeology (3) II Geologic and hydrologic factors controlling occurrence and development of ground water. 2R, 3L. Field trips. P, Geos. 101. (Identical with Geos. 531) S. Davis


536. Development of Ground-Water Resources (3) II Analytic techniques to evaluate geohydrologic systems; case histories used to study management of ground- and surface-water resources; planning and design of regional water resource investigations. Field trips. P, 535. (Identical with Geos. 536) S. Davis

540.* Advanced Surface Water Hydrology (3-4) II Theory and selected design problems from fluvial dynamics, flood hydrology, flood routing, and water supply hydrology. 3R, 1D. Discussion section is mandatory for undergraduates. Field trip, P, 519 or 523. Ince

543.* Quantitative Planning Methods in Water Resources Administration (3) I Application of quantitative methods to water resource management; benefit-cost analysis; optimization; structure and basis of planning process; risk analysis. P, microeconomics, Math. 125a. D. Davis

544.* Quantitative Design Methods in Water Resources Administration (3) II Applications of quantitative methods to water resource management; benefit-cost analysis; optimization; operations research methods (linear, quadratic, and dynamic programming). P, FORTRAN, microeconomics, Math. 125a. Maddock

545.* Statistical Hydrology (3) II Application of statistics and probability to uncertainty in the description, measurement, and analysis of hydrologic variables and processes, including extreme events, error models, simulation, sampling, and optimization. P, knowledge of computer language, Stat. 160 or 361. D. Davis

550.* Environmental Hydrology (4) II Chemistry of surface and subsurface water, the predominant chemical processes affecting composition in relation to man's use; classification, identification, and mobility of contaminants; introduction to chemical and transport modeling. 2R, 3L. P, Chem. 103a-103b, Math. 125b, knowledge of computer language. Bassett

557.* Low Temperature Geochemistry (3) II (Identical with Geos. 557)

560.* Watershed Hydrology (3) I (Identical with WS.M. 560)

561. 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. 561) Maddock

563. Isotope Hydrology (3) I (Identical with Geos. 563)

570. Computer Simulation of Hydrochemical Processes (3) I Introduction to the fundamental chemist's problem of solving complex water chemistry problems using computer codes as tools. Equilibrium, mass transfer, or 1-D transport models with multielement chemistry, thermodynamic concepts, and use of equations in models; placing natural chemical processes into an interpretable framework, evaluation of error and uncertainty. 2R, 3L. P, CR, 506 (recommended) or 517R-517L. Bassett

571.* Water Quality Control (3) II (Identical with C.E. 571)

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)

578.* Global Change (3) II (Identical with Geos. 579)

581.* Environmental Policy (3) II (Identical with Pol. 581)

582.* Hydrologic Systems (3) II Introduction to ground-water flow and transport modeling, with emphasis on model construction and simulation. 2R, 3L. Maddock

583.* Physical Oceanology and Limnology for Hydrologists (2) I Origin, distribution, and characteristics of oceanic water; advective and convective processes; estuarine and shoreline processes; effect on coastal aquifers; classification and hydrologic regimen of lakes. P, Math. 125b. Bales

*May be convened with 400-level course.

596. Seminar

k. Risk and Society (3) [Rpt./1] I (Identical with Geog. 596k, which is home)

603. Well Hydraulics and Pumping Test Analysis (2) II 1992-93 Flow to wells in aquifers, with emphasis on design and interpretation of pumping tests; confined, unconfined, and leaky aquifer systems; fractured rocks. P, 503 or 535. Neuman

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

642. Analysis of Hydrologic Systems (3) I Presentation and evaluation of a variety of mathematical modeling techniques; presentation of theoretical basis of linear/nonlinear systems, advantages and limitations of various approaches, e.g., linear vs. nonlinear, lumped vs. distributed, used in hydrologic modeling; interrelation between function development and model calibration requirements. P, Math. 254. Sorooshian

643. Water Resources Systems Analysis (3) II Applications of mathematical programming to the analysis of interactions of hydrology, engineering, economics, and socio-institutional environment in regional water resources systems. P, 521 or consult department before enrolling. Buras


655. Stochastic Hydrology (3) I 1991-92 Advanced application of statistics and probability to hydrology; multivariate regression, Bayesian techniques, Markov chains, time series and frequency analysis, optimal interpolation and forecasting, P, 519 or 545. Entekhabi

695. Colloquium

a. Hydrology and Water Resources Administration (1-3) [Rpt./1] I For majors only; consult department before enrolling.

696. Seminar

b. Unsaturated Flow (1-3) I II
c. Pollutants in the Hydrologic Environment (1-3) I II

d. Advanced Hydrologic Modeling (1-3) II
e. Advanced Topics in Hydrochemistry (1-3) I 1992-93 P, 506 or consult department before enrolling.

f. International Water Resource Management (1-3) [Rpt./2] I (Identical with Pol. 696I, N.E.S. 696)
g. Water Quality Planning and Policy (1-2) II

h. Science and Technology of Radioactive Waste Management (1-3) [Rpt./1] I 1992-93

i. Water Storage Systems (1-3) [Rpt./1] II P, consult department before enrolling.

697. Workshop

a. Interdisciplinary Problem Solving in Natural Resources I (2) I II 697a/697b is a two-semester sequence. Credit and grade for 697a will be awarded only upon completion of 697b. P, consult department before enrolling. (Identical with R.N.R. 697a Lord, Fogel, Glennon, Maddock, Schager, Wilson

120 HYDROLOGY AND WATER RESOURCES
b. Interdisciplinary Problem Solving in Natural Resources II (2) I II 697a/697b is a two-semester sequence. Credit and grade for 697a will be awarded only upon completion of 697b. P. 697a. (Identical with R.N.R. 697b) Lord, Fogel, Glennon, Maddock, Schager, Wilson.

**Industrial Engineering**

(See Systems and Industrial Engineering)

**Interdisciplinary Graduate Programs**

1010 N. Martin Avenue
(602) 621-5368

Interdisciplinary graduate programs are offered by the following committees:

- American Indian Studies
- Applied Mathematics
- And Lands Resource Sciences
- Biophysics
- Cancer Biology
- Cognitive Science
- Comparative Literature and Literary Theory
- Environment and Behavior
- Epidemiology
- Genetics
- Gerontology
- History and Philosophy of Science
- Latin American Studies
- Medieval Studies
- Neuroscience
- Nutritional Sciences
- Optical Sciences
- Pharmacology and Toxicology
- Physiological Sciences
- Planning
- Remote Sensing
- Second Language Acquisition and Teaching

For a specific program listing, refer to the committee name in this section.

For additional information, see “Office of Interdisciplinary Graduate Programs” under the General Information section elsewhere in this catalog.

**Italian**

(See French and Italian)

**Japanese**

(See East Asian Studies)

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**Journalism (JOUR)**

Franklin Building, Room 101M
(602) 621-7556

Professors George W. Ridge, Jr., Head, Donald W. Carson, Abraham S. Chanin, Philip Mangelsdorff (Emeritus), Jacqueline E. Sharkey

Associate Professors Ford N. Burkhart, William F. Greer, James W. Johnson, Jim Patten

Assistant Professors Virginia Escalante, Addie M. Rimmer

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 obtaining an academic background in one or more specializations.

An undergraduate major in journalism is not necessary for admission. Students are required to complete 205, 206, and 320 as deficiencies without graduate credit.

A minimum of thirty units is required for the master's degree. Electives can be chosen from journalism or related fields with the approval of the adviser. A complete program of study must be approved by the graduate adviser in the first semester, and the adviser must approve any subsequent changes. No foreign language proficiency is required, although for those interested in Latin America, the department has an exchange program in Guadalajara.

Students are required to work on two departmental newspapers and to demonstrate a high level of skill in reporting and writing courses. The program of study must include 511, 513, 502, 509, 596a, and 909. An 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) I 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) I II Reporting and interpreting the news through photos, photo documentaries, and photo analysis. Open to majors only. P. 301, 302.

505. **The Study of News** (3) I II Critical study and problem analysis of the media. Field work may include publication of conclusions.

506. **Magazine Color Photography** (3) S Techniques for taking and editing color photographs to illustrate magazine articles. Preparation of resumes and photo portfolios. Graduate-level requirements include additional readings and two additional photo assignments. Field trips.

511. **News Features** (3) I II Writing the basic news feature article; specialized reporting and rewriting techniques. P. 206.


513. **Reporting Public Affairs** (3) I II Study and practice of news-gathering on executive, legislative, and judicial levels in city, county, state and federal governments, with emphasis on news sources and interpretive writing. P. 206, 502.

514. **The News Agency: Arizona News Service** (1) [Rpt.] I II Role and operations of the news agency, wire service or syndicate. Class members will form staff of Arizona News Service to supply client newspapers from bureaus in Tucson and Phoenix. Field trips. P. CR, 411 or 413.

515. **The Editorial Page** (3) I II Critical study of opinion-makers, with emphasis on editors and public-affairs columnists; analysis of editorial pages in a changing society; writing of editorials. P. 206.

517. **Sports News Writing** (3) I II Students will cover sports events and write sports features. Interview and rewriting techniques. P. 206.

518. **Public Information Writing** (3) I II S The history, principles and techniques of public information, the relation between news media and government, and the responsibilities of government and other public information specialists. P. 206.


522. **Publications Layout and Design** (3) I II Theory and practice of layout, typography, and design for magazines. P. consult department before enrolling.

539. **Ethics and the News Media** (3) I Analysis of ethical theory and how it relates to journalists' roles and responsibilities in a democratic society. Case studies involve questions of bias, accuracy, privacy and national security. (Identical with L.A.S. 539 and Phil. 539)

550. **Community Journalism: The Tombstone Epitaph** (3) [Rpt.] I II Class members work as editorial staff to produce the local newspaper for Tombstone, Arizona. Intensive study of problems and responsibilities of community newspapers. P. 206, 208, 301, discussion of preparation with instructor.

551. **Community Journalism: El Independiente** (3) [Rpt.] I II Class members work as editorial staff to produce a publication for the community of South Tucson. Intensive study of problems and responsibilities of journalism. P. 206, 208, 301, discussion of preparation with instructor.

552. **Press Criticism: The Pretentious Idea** (3) I II Study of press criticism, including the publication of a press review. Open to majors only. P. 206, 208, discussion of preparation with instructor.

570. **The Press and Society** (3) I II Critical study of press performance in current affairs; changing requirements for socially responsible and professional journalism in a democracy.

596. **Seminar**

c. Reporting Governmental Affairs (3) I II
f. Community Journalism (3) I II
h. Latin-American Press (3) I II (Identical with L.A.S. 596h)
i. News Analysis (3) I II
k. Risk and Society (3) I (Identical with Gaog 596k, which is home)
approximately 50 faculty members from numerous departments teach Latin American-related courses and participate in outreach and grant programs sponsored by the center.

A total of 36 graduate units is required for the M.A. degree. A minimum of 15 units, including a research seminar, are chosen in the area of concentration. Related studies consist of a minimum of nine units in a second area and six units in a third area. The six remaining units consist of elective course work or thesis credits. The student is strongly encouraged to include one or two seminars in related studies or elective course work areas.

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. 206 or Span. 301b 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 are required to complete at least one semester of L.A.S. 596a.

Applicants are asked to submit two letters of recommendation, a one-page statement of purpose or goals, and scores on the Graduate Record Examination. An admissions subcommittee takes into consideration all factors when evaluating applicants to the graduate programs. Doctoral students in other departments may elect a minor in Latin American studies. Requirements include a minimum of 15 units in courses related to the student's major and demonstrated competence, as defined above, in either Portuguese or Spanish.

505.* Advanced Composition and Conversation (3) I (Identical with Span. 505)
509.* Economic Anthropology (3) II (Identical with Anth. 509)
511.* Middle America (3) II (Identical with Geog. 511)
512.* South America (3) I (Identical with Geog. 512)
515.* Creative Writing in Spanish (3) II (Identical with Span. 515)
517.* Cultures of Ancient Mexico (3) S (Identical with Anth. 517)
522a-522b.* Pre-Columbian Art (3-3) (Identical with Ar.H. 522a-522b)
523.* Peoples of Mexico (3) II (Identical with Anth. 523)
530. Hispanic-American Chronicles (3) I 1991-92 (Identical with Span. 530)
531.* Anthropology and Development (3) II (Identical with Anth. 531)
532.* Pre-Columbian Culture and Myths (3) II 1992-93 (Identical with Span. 532)
533. Colonial Narrative Fiction (3) I 1992-93 (Identical with Span. 533)
537.* Democracies, Emerging and Evolving (3) I (Identical with Pol. 537)
538. Pre-Columbian Literature (3) I 1991-92 (Identical with Span. 538)
539.* Ethics and the News Media (3) I (Identical with Jour. 539)
541.* Children's Literature in Spanish (3) I (Identical with Span. 541)
542.* Mexican-American Poetry (3) I 1992-93 (Identical with Span. 542)
543.* Mexican-American Literature (3) II (Identical with Span. 543)
544.* Mexican-American Narrative (3) I 1992-93 (Identical with Span. 544)
545.* Novel of the Mexican Revolution (3) I (Identical with Span. 545)
547* Latin American Political Development (3) II (Identical with Pol. 547)
548.* Government and Politics of Mexico (3) I (Identical with Pol. 548)
549.* Brazilian Literature in Film (3) I 1992-93 (Identical with Port. 549)
550.* Religion and Politics (3) II (Identical with Pol. 550)
553a-553b.* Mesoamerican Archaeology (3-3) I (Identical with Anth. 553a-553b)
554.* Andean Archaeology (3) II (Identical with Anth. 554)
556.* Central America: From Colonialism to Revolution (3) II (Identical with Hist. 556)
557.* Inter-American Politics (3) I (Identical with Pol. 557)
558.* Agricultural Economic Development in Latin America (3) II (Identical with Hist. 559)
564.* History of Argentina (3) I (Identical with Hist. 564)
565.* Women in International Development (3) II (Identical with Anth. 565)
566.* History of Brazil (3) II (Identical with Hist. 566)
567.* Contemporary Latin America (3) I (Identical with Hist. 567)
568. Spanish-American Nineteenth Century Novel (3) II 1992-93 (Identical with Span. 568)
569.* History of Women in Latin America (3) II (Identical with Hist. 569)
572. Spanish-American Vanguardist Poetry (3) II 1992-93 (Identical with Span. 572)
575c. Spanish-American Novel of the Twentieth Century (3) (Identical with Span. 575c)
595. Colloquium a.* Latin American Studies (3) [Rpt. ] I P, Spanish or Portuguese proficiency.
b. Advanced Studies in Latin American History (3) [Rpt. ] I II (Identical with Hist. 595b, which is home)
c. Latin American Studies Special Topics (3) [Rpt. ] I (Identical with Hist. 595c)

b. Comparative Politics (3) [Rpt. ] I II (Identical with Pol. 596d)

620. History of the Spanish Language (3) I 1991-92 (Identical with Span. 620)
621. Spanish in the Americas (3) I 1992-93 (Identical with Span. 621)
Law (LAW)

Law Building, Room 110
(602) 621-1373


Associate Professors Leslie Espinoza, Lakshman Guruswamy, Jane B. Korn, Patricio R. Lopez

No graduate degree is offered by the College of Law. The College welcomes, however, the enrollment of properly qualified graduate students in selected courses relevant to their degree objectives. Graduate students so enrolled may earn graduate credit as their performance warrants. Prior to registration, such students must obtain the written approval of the instructor of the course in question and the Executive Committee of the College of Law.

For information concerning the professional degree Juris Doctor, see the College of Law Catalog.

600. Contracts (5)
601a-601b. Introduction to Legal Process and Civil Procedure (3-2)
602. Criminal Procedure (4)
603. Research and Writing (2)
604a-604b. Torts (2-3)
605. Property (5)
606. Constitutional Law I (3) I
607. Appellate Practice and Moot Court (1)
608. Evidence (4)
609. The Legal Profession (2)
610. Health Law (3) I I
611. Employment Law (3) I I
612. Family Law (3) I I
613. Law and Medicine (3) I I
614. Workers’ Compensation (2) I I
615. Constitutional Law II (4) I I
616. Corporations (3) I I
617. Corporate Finance (2) II P, 616.
618. Antitrust Law (3) I I
619. Estates and Trusts (4) I I
620. Immigration Law (3) I I
621. Administrative Law (3) II
622. Law Review (1-3) I I
623. Conflict of Laws (3) II
624. Labor Law (3) I I
625. American Legal History (2) I I
626. Jurisprudence (3) I I
627. Copyright (2) I I
628. Comparative Law (3) I I
629. Agency and Partnership (2) I I
630. Law and Humanities (3) I I
631. Indian Law (3) I (Identical with A.In.S. 631)
633a-633b. Commercial Transactions (3-3) 633a is not prerequisite to 633b.
634. Basic Insurance (3)
635. Federal Tax Procedure (2) I II P, 646.
636. Real Estate Planning (3) I I
637. Real Estate Transactions (3) I I
638. Real Estate Planning (3) I I
639. Community Property (2) I I
640. Mining and Public Land Law (3) I I
641. Water Law (3) I I
642. Federal Jurisdiction (3) II
643. Arizona Civil Procedure (3) I I
644a-644b. Remedies (1-3)
645a-645b. Trial Practice (2-3) P, 608, 609.
646. Federal Income Taxation (5) I I
647. Corporate Taxation (3) I II P, 646.
648. Estate and Gift Taxation and Basic Estate Planning (2) I I
649. Torts II (3) I I
650. Criminal Law (3) II
651. Accounting and the Law (2) II
652. Income Taxation of Estates and Trusts (2) II P, 646.
653. Advanced Appellate Practice and Moot Court (2) II
654. The First Amendment (3) II 1991-92
656. Securities Regulation (3) II
657. Land-Use Planning (3) I I
661a-661b. Moot Court Board (2-1) 661a I: Moot Court National Team. 661b II: Moot Court Board.
662a-662b. Debtor-Creditor Law (1-2) I I
663. Individual Income Tax (3) I I
664. Law and Social Science (2) I I
665a-665b. Interviewing, Counseling and Negotiating (1-1) 665a is not prerequisite to 665b.
666. Lawyering Skills Outside the Courtroom (2) I II P or CR, 698c or substantial clerkship experience.

667. Law and Economics (3) II
668. Pretrial Litigation (3) II I P, 608.
670. International Law (3) II
671. Business, Government and Society (3) II (Identical with M.A.P. 671)
675. Advanced Legal Writing (2) II
677. The English Legal System (1) I I
679. International Civil Litigation (1)
686. International Law (3) II (Identical with M.A.P. 671)
696. Seminar I

604a-604b. Torts (2-3)
605. Property (5)
606. Constitutional Law I (3) I
607. Appellate Practice and Moot Court (1)
608. Evidence (4)
609. The Legal Profession (2)
610. Health Law (3) I I
611. Employment Law (3) I I
612. Family Law (3) I I
613. Law and Medicine (3) I I
614. Workers’ Compensation (2) I I
615. Constitutional Law II (4) I I
616. Corporations (3) I I

Library Science (LIS)

1515 East First Street
(602) 621-3565

Graduate Library School

Professors Charles D. Hurt III, Director, Ellen Altman, Donald C. Dickinson, Margaret F. Maxwell, Lawrence Clark Powell (Emeritus), Elnor C. Sattus (Emerita), Arnulfo D. Trejo (Emeritus)

Associate Professors Helen M. Gothberg, Helen Renthal (Emerita), Ronald A. Van De Voorde (Emeritus)

Assistant Professors John M. Budd, Charles A. Seavey, Gretchen Whitney

The Graduate Library School offers a program leading to the Master of Library Science degree. The program is fully accredited by the American Library Association.

The program requires completion of a minimum of thirty-eight units of graduate credit. No thesis is required. A more detailed description of the program is available from the Graduate Library School.

Degree

Master of Library Science: For information concerning this degree, see Requirements for Masters’ Degrees/Master of Library Science elsewhere in this catalog.


503. Library Collection Development (3) I I Principles of collection development; evaluation and review of materials; selection tools; acquisition of materials; problems in selection, including censorship.

504. Foundations of Library and Information Services (3) I I Elements of librarianship,
<p>vey of the history of books and printing from ancient to modern times. (Identical with Hist. 559.)</p>
complete the following courses: 503, 504, 505, 510, 514, 515, 522, 535, 564, and 595a (two semesters). These courses cover the foundations and major current developments in the phonology, morphology, syntax and semantics of natural languages.

Master of Arts: A total of 30 units of course work is required, including all of the courses listed above. A master's examination consisting of the submission of an expanded term paper is required. The paper must be approved by a committee of the student's advisor and two other faculty members. No thesis is required.

Doctor of Philosophy: In addition to the courses listed above, students must complete 697a, two seminars and a dissertation. Additional courses and seminars are required depending on the student's area of specialization and minor field. A minor taken within the department consists of 12 units. The qualifying examination consists of the submission of two research papers to the faculty, normally at the end of the third semester. The written preliminary examination consists of the submission to the faculty of a research paper of the scope of a journal article, normally at the end of the fifth semester. A dissertation proposal must be approved by the student’s dissertation director within six months of passing the oral preliminary examination. Further information about the graduate program is provided in the Handbook of Policy for the Graduate Program in Linguistics, which is available upon request from the department.

500. Linguistics for Nonmajors (3) I II Conceptual foundations, methodology, and current theoretical frameworks. Students will carry out actual linguistic analysis. For students in fields other than linguistics.

503.* Foundations of Syntactic Theory I (3) I Introduction to fundamental issues in the theory of syntax. Familiarizes the student with the essentials of (1) government binding theory and its precursors, and (2) standard categorial grammar and its relatives. P, 101. 300.

504. Government Binding Theory (3) II Continuation of 503, focusing on government, control, binding, thematic relations, and the theory of logical form.


510.* Foundations of Phonological Theory I (3) I Investigation of the principles that underlie current phonological theory, concentrating on the representation of sounds and the regular patterns of sound in natural language. Topics include distinctive feature theory, syllable theory, the core skeleton, rule formulation and rule interactions. P, 101. 315.

511.* Introduction to Japanese Linguistics (3) (Identical with Jpn. 511)

512.* Introduction to Japanese Linguistics (3) (Identical with Jpn. 512)

514. Foundations of Phonological Theory II (3) II Investigation of the evidence and arguments for non-linear representations (autosegmental and metrical) and of the organization of the phonological component of grammar, including evidence for its interaction with morphological structures and rules.

515. Phonological Phonetics (3) I Study of the acoustic and articulatory properties of sounds and patterns of sounds that occur in human language. Focus on the significance of the properties of sounds for phonological theory, in particular, distinctive feature theory. Role of psycho-acoustic studies as a source of evidence for phonological theory.

519.* Linguistic Structure of Modern Chinese (3) (Identical with Chn. 519)

520.* Linguistic Structure of Modern Chinese (3) (Identical with Chn. 520)

522.* Linguistic Semantics and Lexicology (3) II 1992-93 Study of word and sentence meaning, relationship between the lexicon and the grammar, idioms, metaphor, etymology, and change of meaning. P, one course in linguistics. (Identical with Phil. 522)

523a-523b.* Theory of Spanish Syntax (3-3) (Identical with Span. 523a-523b)

526.* Introduction to Arabic Linguistics (3) II (Identical with N.E.S. 526)

527.* Applied Linguistics (3) I (Identical with Span. 527)

530.* Language Variation (3) II Study of geographical and social dialects, stylistic differences, and ideological variation and the implications of variation for writing grammars and for understanding language change. P, 101 or consult department before enrolling.

535. Morphology (3) I Morphology is the internal structure of words and the relationship between words and the syntactic, phonological, and semantic properties of the units that include them. Course work includes the development of morphological theory.

540. Linguistic Change and Diachronic Theory (3) I II Current theories in historical linguistics, including the study of the mechanisms underlying changes of language and the methods of linguistic reconstruction. Particular language areas and areas of linguistics vary with the instructor. (Identical with N.E.S. 540)

544. Syntactic Analysis (3) I An examination of the syntactic diversity presented by natural human languages and an exploration of the issues that such diversity presents for syntactic analysis. Topics include AUX, word order, constituency, and subjects.

551.* Language Acquisition (3) II (Identical with Sp.H. 551)

561. Linguistics and the Study of Literature (3) II 1992-93 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 Cpl.LI 561)

564. Formal Semantics (3) (Identical with Phil. 564)

565.* Pragmatics (3) I II Study of language use, its relationship to language structure and content; topics such as speech acts, presupposition, implication, performatives, conversations. (Identical with Phil. 565)

573.* Natural Language Processing (3) II Introduction to the processes underlying speech production and comprehension: speech sounds, words, parsing, semantics and pragmatics. P, 101. (Identical with Phil. 573 and Psych. 573)

576.* Language in Culture (3) II (Identical with Anth. 576)

577.* Discourse and Text (3) II 1991-92 (Identical with Anth. 577)

580.* Historical Comparative Linguistics (3) I (Identical with Anth. 580)

583. Sociolinguistics (3) I (Identical with Anth. 583)

585.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

588.* Computational Linguistics (3) I Fundamentals of formal language theory; syntactic and semantic processing; the place of world knowledge in natural language processing. P, a course in one of the following: formal languages, syntax, data structures, or compilers. (Identical with C.Sc. 588 and Psych. 588)


600. Current Issues in Linguistic Research (3) [Rpt./1] Current research in linguistics, with emphasis on relationships among syntax, semantics, and phonology.

606. Seminar a. Syntax and Semantics (3) [Rpt./2] I II b. Topics in Phonological Theory (3) [Rpt./2] I II c. Diachronic Linguistics (3) [Rpt./2] I II d. Current Issues in Syntactic Theory (3) I [Rpt./2] II f. Linguistic Investigations and Applications (3) I I (Identical with Comm. 696I, which is home) g. Topics in Experimental Phonology (3) [Rpt./2] h. Topics in Morphology (3) [Rpt./2] II S

697. Workshop a. Linguistic Theory (3) I Open to majors only.

Management
(See Management and Policy)

Management and Policy (MAP)

Harvill Building, Room 409
(602) 621-1035

Professors Michael R. Gottfredson, Head, Lee R. Beach, Don L. Bowen (Emeritus), Terence Connolly, Edwin B. Filippo (Emeritus), Barbara A. Gutek, James P. Logan (Emeritus), June M. Morrison (Emeritus), Raymond A. Mulligan (Emeritus), Thomas R. Navin (Emeritus), Amnon Rapoport, Arthur L. Silvers, George W. Summers (Emeritus)
Associate Professors Marvin Fortman, H. Brin- 
ton Milward, Gregory B. Northcraft, David A. Tansik, Robert E. Tindall  
Assistant Professors Lawton R. Burns, Jol- 
enie R. Gaiegher, Terri L. Griffith, Sherry K. Schneider, Christina Shalley  

The department offers a program leading to the Master of Science degree with a major in man- 
agement and policy and concentrations in crimi- 
nal justice administration, human resource man- 
agement, organizational strategy, and pol- 
icy and planning. The department also partici- 
pates in programs leading to the Master of Business Administration, the Master of Public Administration, and the Doctor of Philosophy degree with a major in management. For infor- 
mation concerning these degrees, see Re- 
quirements for Master's Degree/Master of 
Business Administration and Master of Public Administration elsewhere in this catalog.  

For admission, the applicant is expected to have completed undergraduate work in man- 
agerial accounting, economics, finance, organi- 
zational behavior, marketing, business law, 
business policy, statistics, and mathematics 
through calculus (Math. 119 and 123). Appli- 
cants must submit scores on the Aptitude Test of the Graduate Record Examination or the Graduate Management Admissions Test.  

The program for the Master of Science de- 
gree in management and policy requires com- 
pletion of thirty units, including a thesis. A mini- 
 mum of sixteen units must be taken in courses 
open only to graduate students. Each graduate 
study program is individually planned in con- 
sultation with an advisor.  

The program for the Doctor of Philosophy de- 
gree is designed to prepare individuals for ca- 
rees in academia, government, or industry 
where the main emphasis is on the ability to 
make original and significant contributions to 
the disciplines of management and policy 
through high quality research. To this end, the 
Ph.D. program provides strong theoretical and 
methodological training to doctoral students.  

500. Management Case Analysis and Pre- 
presentation (3) I II Written analysis of cases and 
other reports; development of skills in analysis, 
decision making, and written and oral presenta- 
tion, with emphasis on the total situation of 
the disciplines of management and policy 
through high quality research. To this end, the 
Ph.D. program provides strong theoretical and 
methodological training to doctoral students.  

503. Human Resource Management (3) I 
Principles, methods, research relevant to man- 
agement of an organization's human resources, 
with emphasis on employment psychology, 
training, development, compensation. P. 305 or 
502.  

504. Organization Development and 
Change (3) I Concepts and skills relevant to 
the management and policy of organizations 
concerned with problem diagnosis and 
organizational development and change. P. 305 or 
502.  

506. Fundamentals of Physical Planning (3) 
Basic considerations in site analysis and plan- 
ning, and transportation and utility systems; 
subdivision planning and plat review. (Identical 
with Ping. 506)  

507. Social Service Planning (3) I Survey of 
the variety of planning efforts designed specifi- 
cally to increase social welfare through the de- 

delivery of services using historical, comparative, 
and evaluative perspectives. (Identical with 
Png. 507)  

514. Cost-Benefit Analysis (3) II (Identical 
with A.Ec. 514)  

532. Conflict and Cooperation in the Dyad 
(3) I Critical exposition of the essential ideas of 
two-person game theory and the findings of ex- 
perimental research on strategic interactions in 
the dyad. (Identical with Png. 532)  

535. International Management (3) I II S 
Analysis of management opportunities and 
challenges; evaluation and formulation of strat- 
egies of firms expanding internationally.  

537. Finance for New Ventures (3) I (Identical 
with Fin. 537)  

538. Marketing, Negotiation and Decision 
Tactics (3) I Development of bargaining and 
decision-making skills through simulated nego- 
tiation and role playing. Open only to students 
in the entrepreneurship program. P, Econ. 
500a-500b, Fin. 511, Mktg. 500. (Identical with 
Mktg. 538)  

539. Planning of New Ventures (3) I II New 
venture development, financial projections, 
resource assessment, and long-range planning. 
Open only to students in the entrepreneurship 
program. P, Econ. 500a-500b, Fin. 511, Mktg. 
500. (Identical with Fin. 539)  

540. Healthcare and Public Policy (3) I II 
Theories of crime applied to public policy 
issues. The relationship between scientific anal- 
ysis of crime and formation of public policy. 
(Identical with Soc. 540)  

545. Interactive Behavior in Small Groups 
(3) I Critical survey of the essential ideas of 
interpersonal behavior (n2) and the findings of 
empirical research on social dilemmas bar- 
gaining and coalition formation. (Identical with 
Pscy. 545)  

554. Research Methodology (3) I Behavioral 
research techniques; bias, validity, reliability, 
and applicable statistical techniques; critiques of 
research articles and reports.  

557. Law of the Elderly (2) I Examines the 
legal aspects of their relationship to other land uses and func- 
tions. (Identical with A.Ec. 514)  

560. Trends in Management Theory (3) I 
Review of management practices from the Indus- 
trial Revolution to modern high technology 
organizations. Focus on contemporary 
organizational issues and managerial 
responses to them. P. 305 or 502.  

561. Design and Control of Production Sys- 
tems (3) I (Identical with M.I.S. 567)  

568. Environmental Scanning (3) I (Identical 
with Mktg. 568)  

571. Business Strategy and Policy Making 
(3) I Case method approach to problems and 
policies facing top management in making and 
effecting a strategic plan. P. 500, 502, Fin. 511, 
Mktg. 500. To be taken in the final semester of the M.B.A. program. Open only to students ad- 
mitted to B.P.A. graduate programs. An M.B.A. 
integrative course.  

575. Housing and Residential Areas (3) II 
Physical, social, and economic aspects of 
property development and residential areas and 
their relationship to other land uses and func- 
tions. (Identical with Ping. 575)  

580a-580b. Theory of Management and 
Organization (3-3) 580a. Analysis of behavior in 
organizational settings; review of classical, 
behavioral, and contingency theories of manage- 
tment, with emphasis on the use of decision mak- 

gers. 580b: Organizations in their environments; analysis of organizations in the 
context of their environmental interfaces. P. 305 or 
502. 580a is not prerequisite to 580b.  

586. Behavioral Research in Judgment and 
Decision Making (3) I Theory and research on the 
strategies and abilities of human judgments and 
decision makers. Focus is upon behavioral, 
as opposed to normative, investigation, and 
upon methods of improving judgment and deci- 
sion performance. P. 586. (Identical with 
Pscy. 586)  

595. Colloquium 
a. Local Government Administration (3) 
[Req. 12 units] I b. Health Care (3) [Req. 12 units] I c. 
Aging and Society (3) [Req. 12 units] I d. 
Civil Rights and Social Change (3) [Req. 12 units] I e. 
Criminal Justice (3) [Req. 12 units] II  

600. Behavioral Science Theory and 
Method in Management (3) [Req. 12 units] II Concep- 
tual and theoretical frameworks for the analysis of 
management problems from a humanistic science 
perspective. Emphasis on formulation of research questions and alternative research 
strategies for addressing them.  

601. Public Management (3) II Fundamentals of management and policy issues 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 
planning and policy analysis; forecasting, 
service demand, facility location in capital 
investment programming, task sequencing, 
program analysis and evaluation. P. 457 or 552. 
(Identical with Ping. 602)  

604. Research and Evaluation in Public Ad- 
ministration (3) I Research and evaluative 
methodologies which support public sector pol- 
icies and administration, including the philo- 

dosophical basis of these methods and a 
research design exercise. P. 601.  

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, evalu- 
ation of strategy and effectiveness of public pol- 
icy and planning. (Identical with Geog. 609 and 
Png. 609)  

610a-610b. Fiscal and Budgetary Admin- 
istration of Public Agencies (3-3) 610a: Intern- 
al fiscal operations and the budgetary cycle of 
public and nonprofit agencies. P. 601, Acct. 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 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. P. 650.

650. Analysis of Health Systems (3) I Introduces the student to the scope and nature of public and private health systems in the U.S.; examines roles of government and private enterprise in the development and operation of health institutions. P. 601.

651. Health and Public Policy (3) II Examines public policy issues in health, including recent developments in health policy and planning at the national, state and local levels, and their impact on administrative behavior. P. 650. (Identical with Ping. 651)

652. Management of Long Term Care Facilities and Programs (2) II Problems and principles of management of facilities and community-based programs providing health and social services to the chronically impaired. P. 650.

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. 500a. (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. 305 or 502. (Identical with Law 671)

693. Internship

b. Criminal Justice (1-6) I II
   c. Public Management (1-6) I II
   d. Health Services Administration (1-6) I II
   f. Long Term Care Administration (1-6) I II
   g. Policy and Planning (1-4) S Open to majors only. (Identical with Ping. 693g)

696. Seminar

a. Development Administration (1-3) I II
b. Program Planning and Development (1-3) III
c. Performance Measurement and Accountability (1-3) III
d. Judgment and Decision Making (3) [Rpt.2] P 596. (Identical with Psyc. 696d)
e. Health Services Administration (1-3) I II
f. Criminal Justice Administration (1-3) I II
h. Land-Use Regulation (3) I II (Identical with Ping. 696h)
i. Legal Inquiry in Policy and Planning (3) II (Identical with Ping. 696i)
j. Environmental Planning (3) I II (Identical with Ping. 696j)
k. Planning Administration (3) I II (Identical with Ping. 696k)
l. Organizational Behavior (3) [Rpt./6 units] I II P. 600.
m. Organizational Theory (3) [Rpt./6 units] I II P. 600.

6. Research Design: Statistical Methods (2-4) I II

Management Information Systems (MIS)

BPA Building, Room 406 (602) 621-2748

Professors Jay F. Nunamaker, Jr., Head, Andrew Bailey, Seymour Goodman, Barbara Gutek, James F. LaSalle, Averill M. law

Associate Professor Nicholas Aquilano, Moshe Dror

Assistant Professors Al-Mei Cheng, Heichun Chen, Joe George, Pallassana K. Kannan, Titus Purdin, Sudha Ram, Edward Roche, Susan Sanchez, Olivia R. Liu Sheng, Pamela Slaten, Asso Vakharia, Douglas R. Vogel, E. Sue Weber, Suzanne Weisband

The department offers a program leading to the Master of Science degree with a major in management information systems. The department also participates in programs leading to the Master of Business Administration, Master of Public Administration, and Doctor of Philosophy (major in management) degrees.

Management information systems involves the use of computers in organizations and the integration of computer skills with the functional areas of management. Education in management information systems enables students to pursue careers involving the use, definition, analysis, design, implementation, and operation of computer information systems.

To be considered for admission, applicants must have earned a competitive, acceptable score on the Graduate Management Admissions Test and a competitive undergraduate cumulative grade-point average. Applicants must also have completed preparatory work in 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 (696h).

501. Management Information Systems (3) I Introduction to managerial issues related to the use and implementation of information technologies in business. Emphasis is on organizational and technical foundations of information systems; problem solving skills using PC-based software. Open only to students admitted to BPA graduate programs.

507a-507b. Information Systems Architecture and Data Communications (3-3) 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. 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. P. 531a.

511. Social Issues of Computing (3) II Survey of the individual, organizational, and cultural impacts of computers; to stimulate reflection upon the social and ethical issues provoked by current and projected uses of computers.

521a-521b. Advanced Systems Modeling and Simulation (3-3) I II The nature of simulation, software, including animation model validation, selecting simulation distributions, random variate generation, statistical analysis of output data. Simulation of manufacturing systems, manufacturing issuing addressable by simulation, SIMAN simulation language, and statistical issues in manufacturing simulation. Open only to students admitted to BPA graduate programs. P. 501, M.A.P. 552, Math. 119, knowledge of Fortran programming, probability and statistics. (Identical with C.Sc. 521a-521b)

522. Mathematical Programming and Applications (3) I II Formulation and solution of mathematical programming models with applications to decision problems involving profit maximization or cost minimization. Topics include linear programming, network flow programming, and integer programming. P. 301, Math. 119.

531a-531b. Data Structures and Database Management (3-3) 531a: Abstract data types, data structures and their implementation in Pascal programs. Data structures covered include stacks, queues, lists and trees. 531b: Introduction to concepts of database processing in comparison with file processing. 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-Aided Information Systems Analysis and Design (3-3) I II Analytic and logical design of M.I.S.; techniques for stating and analyzing information systems requirements including 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.Sc. 541a-541b)

550. Soviet Technology and Science (3) I II 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.

551. Business Systems Programming Methods (3) I II Business systems programming
environment; basic and advanced COBOL: file organization and access methods; external sort and multikey files; 4GLs in data processing. P, 501.

552. Statistical Decision Making (3) I II Probability and statistical analysis; random variables, sampling distributions, hypothesis testing. Bayesian analysis, time series, statistical investigation. Open only to students admitted to a BPA graduate program. P, 400, or Math. 119 and 123.

553. * Software Systems for Business Applications (3) I II Software development and software engineering; brings together the elements of programming language, operating system, and development techniques; teaches and uses the C programming language and the Unix operating system.

*May be connected with 400-level course.

554. Computer Graphics (3) I II Computer graphic display hardware and software components; graphic data structure; pictorial data structures and management. P, 531a.

555. Design and Control of Production Systems (3) I I An introduction to the design of production systems and how decisions about them are influenced by the acquisition and use of accounting data. Manufacturing and service strategy, aggregate planning, inventory control, and JIT. Open only to students admitted to BPA graduate programs. (Identical with M.A.P. 587)

570. Management and Evaluation of Information Systems (3) I II The methodologies of economics and management information systems 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, Acct. 550, Econ. 500a. (Identical with Acct. 570 and Econ. 570)

572. Operations Management (3) I Intended for students without a background in production management. Survey of techniques useful in operating manufacturing and service production.


577. Discrete Mathematical Programming (3) I II Introduction to the formulation, solution, and implementation of discrete and integer mathematical programming models; representative applications will be studied and solved on the computer. P, 422.

578. Systems Design for Management (3) I Decision support system concepts, applications and methodologies for developing and evaluating decision support systems; organizational and technical factors of office automation.


580. Introduction to Expert Systems (3) I 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 variables, inference, remedial measures. 582b: Analysis of variance and covariance, principal components, discriminant analysis, canonical correlation. P, 275 or 552. 582a is not prerequisite to 582b.

585. Manufacturing Strategy (3) I II 1992-93 Manufacturing strategy and related long-term issues; relationship between strategy and operating decisions; new developments in technology.


611a-611b. Topics in Research Methodologies in MIS (3-3) 611a: Introduces beginning doctoral degree students and advanced master's degree students to important research and survey articles in the field of management information systems. 611b: Provides a knowledge of research methodologies used in the MIS discipline, including experimental design, surveys, case studies, field work, and software engineering.

671. Domestic and International Issues (3) I Information technologies and their applications 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 I Managerial and organizational aspects using artificial intelligence (AI) and expert system technology. Advanced topics such as knowledge acquisition, impacts of AI and expert systems on organizations, and strategic advances of AI and expert systems applications will be added. Cases will be used.

696. Seminar


b. Group Support Systems (3)


d. Research Surveys (3)

e. Recent Advances in Management Science (3) P, 422.

g. Mathematical Programming (3) P, 422.

Advanced Topics in Data Management (3) P, 531b.

h. Master's Report Projects (3) S Open only to majors.

i. Management of Executive Information (3) II

766. Seminar

a. Research Issues (3) [Rpt./6 units] Open to majors only.

797. Workshop


Marketing (MKTG)

Harvill Building, Room 347
(602) 621-7479

Professors Dipankar Chakravartii, Head, Joseph W. Newman (Emeritus), John H. Wieland (Emeritus)

Associate Professors Merrie L. Brucks, Bernard J. Jaworski, Christopher H. Puto, Richard A. Scott, Melanie R. Waielland

Assistant Professors Helen H. Anderson, Jonathan Frenzen, Susan E. Hecker, Deborah J. Macniss, Jayashree Mahajan, Kent Nakamoto

The department offers a program leading to the Master of Science degree with a major in marketing. The department also participates in programs leading to the Master of Business Administration degree with a major in business administration and the Doctor of Philosophy degree with a major in management. For information concerning these degrees see Requirements for Master's Degrees/Master of Business Administration and the headnotes under Business Administration elsewhere in this catalog.

The Master of Science degree program prepares students for marketing careers which require strong empirical research skills. The program also is an efficient step toward the Ph.D. program with a major in management for students holding undergraduate degrees.

For admission, the applicant is expected to have completed undergraduate work in managerial accounting, economics, finance, marketing, organizational behavior, production, business policy, statistics, and mathematics through calculus. Some background requirements may be satisfied after admission. A superior score on the Graduate Management Admissions Test and evidence of strong academic performance at the undergraduate level are required for admission consideration.

Credit earned in fulfilling the background requirements named above will not count toward the 39 units of course work required for the M.S. degree. The 39 units include nine units for either a thesis or an internship, one of which is required.

500. Marketing Management (3) I I Scope, environment and nature of marketing management; customer and market analysis for production, service, price, promotion and distribution decisions. Open only to students admitted to B.P.A. graduate programs.

530. Management of Marketing Communications (3) I Application of communications theory and research findings in advertising, sales promotion, publicity, personal selling, planning, conduct and administration of programs of information and persuasion. P, 500.

536. Innovation and Economic Growth (3) I Role of entrepreneurship and innovation in economic growth. Development of the new venture idea and assessment of market potential. Open only to students in the entrepreneurship program. P, Econ. 500a-500b, Fin. 511, Mktg. 500. (Identical with Econ. 536)

538. Marketing, Negotiation and Decision Tactics (3) I (Identical with M.A.P. 538)

550. Consumer and Organizational Buyer Behavior (3) I Nature of the purchase decision

554.* Management of Sales Operations (3) I II The sales function and its relationship to the total marketing program; sales strategies and objectives; development and administration of sales organizations; control and evaluation of sales operations. P, 361, M.I.S. 375, Math. 123.

*May be convened with 400-level course.

557. Industrial Marketing (3) II Problems and methods of marketing decision making in industrial, government and high-tech markets. P, 500.

559. Product Strategy (3) II Formulating and implementing strategy for growth; analyzing and influencing market structure; developing, pricing, testing new entries; managing the portfolio. P, 500.

560. International Marketing (3) II Marketing planning and strategies for foreign environments; cultural, political, economic factors affecting the international marketer, multinational corporation and multinational market groups. P, 500.

565. Global Competitive Strategy (3) II Conducting a comprehensive strategy program for serving a global market; pricing, product development, international expansion, pros and cons of foreign market entry. P, 500.

568. Environmental Scanning (3) I An MBA integrative course. How information from the economy can be used to develop a firm's competitive strategy. Multi-disciplinary, using concepts from economics, marketing and management. Open only to BPA graduate students. P, 500, Econ. 500, Fin. 511. (Identical with Econ. 568 and M.A.P. 568)

572. Marketing Research for Managers (3) I Specification of management information needs, evaluation of research proposals and findings, methodology of gathering and analyzing data, administrative aspects of research and decisions. P, 500.

573. Marketing Research Methods (3) I Survey and qualitative research for marketing management information needs; secondary data search methods; instrumentation, sampling, field work and data analysis; case studies, depth interview and projective methods. P, 500.

583. Consumer Behavior (3) I 1991-92 P, admission to marketing graduate program or approval of department.

d. Consumer Behavior (3) I 1991-92 P, admission to marketing graduate program or approval of department.

e. Marketing Organization and Systems (3) II 1992-93 P, 696a or approval of department.

594. Colloquium (3) I II The sales function and its relationship to the total marketing program; sales strategies and objectives; development and administration of sales organizations; control and evaluation of sales operations. P, 361, M.I.S. 375, Math. 123.

Materials Engineering (See Engineering)

Materials Science and Engineering (MSE)

Mines Building, Room 131
(602) 621-6070

Professors Donald R. Uhlmann, Head, William G. Davenport, Louis J. Demer (Emeritus), J. Brent Hisky, Kenneth L. Keating (Emeritus), W. David Kingery, David C. Lynch, Thomas M. Johnson (Emeritus), Daniel M. Murphy (Emeritus), David R. Poirier, Srini Raghavan, Sigmund L. Smith (Emeritus), Richard A. Swalin, Terry T. Triffet, Michael C. Weinberg

Associate Professor Paul D. Calvert Assistant Professors Dunbar P. Birnie, Pierre A. Dwyer, Brian D. Fabes, Supapan Seraphin, Brian J.J. Zelinski

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in materials science and engineering.

The graduate programs in the department are designed to provide advanced study in the fields of materials properties, materials structures, and materials processing. Emphasis is placed on metals, alloys, electronic materials, ceramics, and composites. Courses and research are provided in extraction, thermodynamics, kinetics, transport, microstructural characterization, physical properties, processing and application.

Degrees

Master of Science: The course requirements for the Master of Science degree are 18 units of regularly scheduled 500-level courses specified by the department; 4 units of colloquium, independent study, or regularly scheduled graduate-level courses; and 8 units of thesis (30 units total). Precise details of the course requirements are available from the department office.

Students may transfer up to six units of course work completed at other institutions. This transfer of graduate credit must be requested from the Graduate College by the student after he or she has satisfactorily completed one semester at the University. A student must take a minimum of 20 units in residence.

Applicants with undergraduate backgrounds in materials science and engineering or in related science disciplines such as chemistry, geology, physics, or other related engineering fields are admitted to the Master of Science program. Graduate students entering the program from other disciplines should have similar mathematics, chemistry, and physics backgrounds as in the undergraduate curriculum in materials science and engineering. Those students who are deficient in any of these courses should take them after admission to the Master of Science program. Doctor of Philosophy: A graduate study program will be designed to ensure that each student acquires a thorough understanding of advanced work in the major field as well as in an appropriate minor. The dissertation, based on original research, is expected to represent a distinct contribution to materials knowledge. It should establish the fact that the candidate is capable of independent, original, and creative thinking. It is not necessary that the research be entirely on a scientific aspect of materials, but may include economic and design considerations as well.

As a general policy, applicants with an M.S. degree in materials science and engineering or an allied field, that includes the completion of a thesis, will be admitted to the Ph.D. program. Exceptional B.S. applicants may be admitted directly into the Ph.D. program. Successful completion of the Ph.D. program includes completion of at least 72 units of graduate courses. This will include (1) 30 units (maximum) from a completed M.S. degree program, courses in a minor program and 18 units of dissertation credit; (2) courses specified by the department including at least 9 units of regularly scheduled M.S.E. graduate courses. Precise details of the course requirements are available from the department office.

503. Applied Surface Chemistry (3) I Fundamentals of surface phenomena, characterization of solid-vapor, solid-liquid and liquid-vapor interfaces, applications in ceramics, electronic and biomedical materials processing. P, a basic course in physical chemistry.

505.* Advanced Extractive Metallurgy (3) II Hydrometallurgy: physical chemistry and kinetics of hydrometallurgical processes including leaching, solvent extraction and metal recovery; flowsheet design and optimization. Pyrometallurgy: analysis, control and optimization of pyrometallurgical processes. Field trip. P 380.


511.* Mineral Processing (3) I (Identical with Min.E. 511)


523.* Electrochemistry in Materials Science (3) I Principles and applications of electrochemistry in materials science with em-
phasis on charge-transfer reactions at electrode-solution interfaces; including electrodeposition, electroforming, electroless plating. P, 240.

524.* Physics and Chemistry of Ceramic Materials (3) II Ceramic crystal structures, crystal chemistry, phase equilibria and sintering theory. P, 260 or consult department before enrolling.


531.* Science and Technology of Magnetic Recording Materials (3) I Magnetic properties of materials, materials for magnetic recording, technology of magnetic recording, P. A basic course in chemistry or materials science.

532. Solid-Fluid Reactions (3) I (Identical with Ch.E. 532)


534.* Electrical and Optical Properties of Semiconducting Materials (3) I Properties of semiconducting materials as related to crystal structure, interatomic bonding and defect structures, P, 360, Phys. 230 or Chem. 480b. (Identical with E.C.E. 534 and Opt. 534)

535.* Corrosion (3) II The science of corrosion reactions and their application to engineering problems. P, 331R, 412 or Chem. 480b or CR. (Identical with Ch.E. 535)

536. Advanced Microstructural Characterization (3) I Theory and applications of modern techniques for characterizing chemical and microstructural features of solids; transmission and scanning electron microscopy, microparticle, and Auger analysis. 2R, 3L, P, 360, 480. Consult department before enrolling.

540.* Thermodynamics of Condensed Phases (3) I Advanced treatment of the principles of thermodynamics with application 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; classical and quantum dynamical models; application to calculation of materials properties (structural, thermodynamic, transport, electronic properties).

552.* Nondestructive Evaluation of Materials (3) II Introduction to the nondestructive testing and evaluation of the various classes of engineering materials. Methods considered include leak detection, penetrant, electromagnetics, radiographic, ultrasonic, electrical, electronic, eddy current, acoustic emission, and thermal. 2R, 3L, P, 331R or 360, or CR.


554. Electronic Packaging Principles (3) I II (Identical with E.C.E. 554)

555.* Physical Metallurgy and Processing of Steel (3) I Equilibrium and nonequilibrium transformations and phases, effects of alloy elements on important transformations in steel, isothermal transformation diagrams and continuous cooling diagrams. Processing aspects include heat treating, heat transfer during cooling and quenching, segregation effects, and surface hardening techniques. 2R, 3L, P, 331R or 360R, 409 or A.M.E. 442.

557.* Integrated Circuit Technology Laboratory (3) I II (Identical with E.C.E. 557)

560.* Materials Science of Polymers (3) I 1992-93: Introduction to physical properties of polymers. Microstructure, crystalization, rheology, relaxation and mechanical properties, P, 331R or 360R.

561.* Biological and Synthetic Materials (3) I 1991-92 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. 103a.

562.* Structure and Properties of Polymers (3) I 1992-93 Topics of intensive current development in polymer science. In each case, the relation between molecular structure, morphology and properties will be explored. Shows how polymers can be designed and tuned to have the properties needed to fulfill specialized functions. Topics include high modulus fibers, nonlinear optical properties, conducting polymers and resins for composite materials. P, 460 or 560.

565.* Microelectronic Packaging Materials (3) I Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered.

570.* Technology of Polymers and Ceramics (3) I Processing and properties of glasses and ceramics in a wide range of technological applications. Discussion of patent literature. P, 260 or 331R.

571.* The Formation and Structure of Glass (3) I The glass transition, Kauzmann's paradox, kinetic theory of glass formation, physics and chemistry of glass making, glass structure, thermal properties, P, 260.


575.* Cultural and Materials Technology (3) I (Identical with Anth. 579)

580.* Experimental Methods for Microstructural Analysis (3) I II An introduction, through a combination of lectures and laboratory experiences, to both established and new techniques for microstructural characterization of materials.

585.* Technological Forecasting (3) I Introduction to basic forecasting technologies which include causal models, trend extrapolation, growth curves, relevance trees and other models. The role of forecasting in business and government will be discussed. P, Math. 125b or knowledge of calculus.

586.* Technology and Society (3) I The evolution of our technological civilization will be discussed with emphasis on possible future models of technological organizations and on the changing roles of the scientist and engineer.

588.* Scanning Electron Microscopy (3) I Theoretical and practical aspects of electron beam microanalysis. Lab emphasizes projects and independent research using scanning electron microscopy and energy dispersive X-ray analysis. 2R, 3L. Field trips. Consult department before enrolling.


595. Colloquium a. Materials (1) [Rpt./5] II

602. Modern Methods in Materials Science (2) [Rpt./4 units] II Discussion of several recent theoretical methods or experimental techniques which have been applied to the study of materials. Topics vary from year to year.

652. Statistical Thermodynamics in Materials Science (3) I Introduction to classical and quantum statistical thermodynamics as applied to materials science. Electronic properties of metals and semiconductors; phase transformations. P, 510 or other classical thermodynamics course.

Mathematics (MATH)
Mathematics Building, Room 108
(602) 621-6892

Professors Alan C. Newell, Head, Clark T. Ben...
The faculty of the Department of Mathematics carries on research (and research seminars) in a variety of purely mathematical and interdisciplinary fields. In algebra and number theory, research includes finite groups, rings, associative algebras, algebraic number theory, and primality testing. Research in analysis is being carried out on bounded operators, quantum fields, relativity, and nonlinear problems of ecology, chemistry, and fluid dynamics. In geometry, there is work on convex sets, incidence geometry, and fibre bundles; in probability and statistics, projects involve geostatistics, reliability theory, and nonparametric inferences. A detailed summary of faculty research appears yearly and is available on request.

502. Mathematical Logic (3) 1991-92 Sentential calculus, predicate calculus; consistency, independence, completeness, and the decision problem. Designed to be of interest to majors in mathematics or philosophy. P, 124 or 125a or Phil. 325. (Identical with C.Sc. 502)

503. Foundations of Mathematics (3) II 1992-93 Topics in set theory such as functions, relations, direct products, transfinite induction and recursion, cardinal and ordinal arithmetic; related topics such as axiomatic systems, the development of the real number system, recursive functions. P, 215. (Identical with Phil. 503)

504. History of Mathematics (3) I The development of mathematics from ancient times through the 17th century, with emphasis on problem solving. The study of selected topics from each field is extended to the 20th century. P, 125b.

511a-511b. Modern Algebra (3-3) Structure of groups, rings, modules, algebras. Galois theory. P, 416 and 416b, or 413 and 415.


514a-514b. Algebraic Number Theory (3-3) 1991-92 Dedekind domains, complete fields, class groups and class numbers, Dirichlet unit theorem, algebraic number fields. P, 511b.

515. Introduction to Abstract Algebra (3) I Introduction to groups, rings, and fields. P, 323.

516. Applications of Algebra (3) II Various applications of abstract algebra, e.g., to coding theory, combinatorial designs, crystallography, etc. P, 415.

517a-517b. Group Theory (3-3) 1992-93 Selections from such topics as finite groups, noncommutative groups, abelian groups, characters and representations. P, 511b.

518. Topics in Algebra (3) [Rpt./36 units] I Advanced topics in groups, rings, fields, algebras; content varies.

519. Topics in Number Theory and Combinatorics (3) [Rpt./36 units] II Advanced topics in algebraic number theory, analytic number theory, class fields, combinatorics; content varies.

and algebraic topology, algebraic geometry, differential geometry; content varies.

553. Algebraic Coding Theory (3) II 1991-92 Construction and properties of error correcting codes; encoding and decoding procedures and information rate for various codes. P. 415. (Identical with E.C.E. 539)

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 C.Sc. 543)


547.* Combinatorial Mathematics (3) II 1992-93 Enumeration and construction of arrangements or designs, theorems on existence and nonexistence of designs, applications to design of experiments and error correcting codes. P. 215 or 243.

550. Mathematical Population Dynamics (4) II (Identical with Ecol. 550)

553a-553b. Partial Differential Equations (3-3) 1992-93 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.


555.* Elementary Partial Differential Equations (3) II Theory of characteristics for first order partial differential equations; second order elliptic, parabolic, and hyperbolic equations. P. 254 or 355.


557a-557b. Dynamical Systems and Chaos (3-3) 1991-92 Qualitative theory of dynamical systems, phase space analysis, bifurcation, periodic doubling, universal scaling, onset of chaos. Applications drawn from atmospheric physics, biology, ecology, fluid mechanics and optics. P. 422a or 422b or 454.


566a.* Theory of Statistics (3) I (Identical with Stat. 566a)

567a-567b. Statistical Inference (3-3) 1991-92 (Identical with Stat. 567a-567b)


573.* Theory of Computation (3) I (Identical with C.Sc. 573)

575a-575b. Numerical Analysis (3-3) Error analysis, solution of linear systems and non-linear systems, eigenvalues interpolation and approximation, numerical integration, initial and boundary value problems for ordinary differential equations, optimization. P. 475b and 455 or 456. (Identical with C.Sc. 575a-575b)

577. Topics in Applied Mathematics (3) I Rpt./36 units I I Advanced topics in asymptotics, numerical analysis, approximation theory, mathematical theory of mechanics, dynamical systems, differential equations and inequalities, mathematical theory of statistics; content varies.

578. Computational Methods of Algebra (3) I Applications of machine computation to various aspects of algebra, such as matrix algorithms, character tables and conjugacy classes for finite groups, group enumeration, integral matrices, crystallographic groups. P. 415 and a knowledge of scientific computer programming language. (Identical with C.Sc. 578)

579.* Game Theory and Mathematical Programming (3) I 1991-92 Linear inequalities, games of strategy, minimax theorem, optimal strategies, duality theorems, simplex method. P. 410 or 413 or 415. (Identical with C.Sc. 579)


583a-583b. Principles and Methods of Applied Mathematics (3-3) Boundary value problems; Green's functions, distributions, Fourier transforms, the classical partial differential equations (Laplace, heat, wave) of mathematical physics. Linear operators, spectral theory, integral equations, Fredholm theory. P. 424 or 422b or CR. 520a.

584.* Operational Mathematics (3) I Basic concepts of systems analysis, Fourier and Laplace transforms, difference equations, stability criteria. P. 421 and 424 or 422b.

585.* 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.I.E. 320a.

586. Case Studies in Applied Mathematics (1-3) [Rpt./6 units] I 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 1992-93 Regular and singular perturbations, boundary layer theory, multiscale and averaging methods for nonlinear waves and oscillators. P. 422a or 422b or 454.

588. Topics in Mathematical Physics (3) I Rpt./36 units I I Advanced topics in field theories, mathematical theory of quantum mechanics, mathematical theory of statistical mechanics; content varies.

589. Nonlinear Wave Motion (3) II 1992-93 Nonlinear partial differential equations describing wave phenomena in water, gases, plasmas, lasers; shocks, modulated wave trains, parametric resonance, solitons and exactly solvable equations. P. 422b or 456 or 455.

590. Colloquium a. Math Instruction (1-3) I I Advanced topics in field theories, mathematical theory of quantum mechanics, mathematical theory of statistical mechanics; content varies.

596. Seminar a. Topics in Mathematics (3) I Rpt./1 S b.* Mathematical Software (3) I I P. 254 or 355, knowledge of "C" programming.

*May be convened with 400-level course.

563. Information Theory (3) I 1992-93 (Identical with E.C.E. 636)

567. Workshop a. Problems in Computational Science (6) I I (Identical with Phys. 697a)

Mechanical Engineering

(See Aerospace and Mechanical Engineering)

Media Arts

Consult the Department of Media Arts at 621-7352.

Medical Technology

(See Health-Related Professions)
891. Preceptorship

595. Colloquium

596. Seminar

801. Preparation for Clinical Medicine (1-12) I II

805. Social and Behavioral Science (6) I II

830. Supplementary Registration (1-9)

896. Seminar

Anesthesiology (ANES)

800. Research (1-6) [Rpt./1]

810. Clerkship

815. Subspecialty

891. Preceptorship

Biochemistry

Cancer Biology

Family and Community Medicine (FCM)

596. Seminar

595z. Colloquium

896. Seminar

800. Research (1-6) [Rpt./1]

810. Clerkship

815. Subspecialty

891. Preceptorship

Anesthesiology (ANES)

596. Seminar
a. Pathophysiology and Immunology of the Clinical Manifestations of Coccidioidomycosis (2) II

800. Research (3-30) [Rpt./30 units] (See College of Medicine Electives Manual.)

803. Clinical Clerkship (12)

810. Clerkship
a. Ambulatory Care (4-6) [Rpt./12 units] II S P, completion of third year medical school.
   b. Ambulatory Diagnosis and Therapeutics (6)
   c. Geriatrics: The Continuum of Care (4) [Rpt./1] P I.Med. 803.
   d. Ambulatory Geriatrics (3-12) P I.Med. 803.

811. Subinternship
a. Internal Medicine (6-12)
   b. Intensive Care (4) P, successful completion of third year medical school.
   c. Coronary Care Unit — Acting Internship (4)
   d. Medical Intensive Care Unit (4)
   e. General Medicine — Acting Internship (4)

815. Subspecialty
a. Clinical Cardiology (4-8)
   b. Clinical Dermatology (3)
   c. Endocrinology (4-12)
   d. Clinical Gastroenterology (4-8)
   e. Hematology-Immunology (6)
   f. Geriatrics (4-6) [Rpt./6 units] P, third year rotation in F.C.M. and I.Med. (Identical with F.C.M. 815f)
   g. Infectious Diseases (4-12)
   h. Pulmonary Diseases (4)
   j. Pulmonary Laboratory and Consultation Service (3-6)
   k. Nephrology, Renal Diseases (3-6)
   l. Clinical Allergy (1-6) (Identical with Ped. 815k)
   m. Medical Subspecialities (3-6) [Rpt.]
   n. Physical Medicine and Rehabilitation (4-6) [Rpt./1] P 3rd or 4th year medical school.
   p. Critical Care Medicine (3-6) (Identical with Anes. 815p)
   q. Cardiology Consultation (4)
   r. Neurological and Neuromuscular Disorders (3-6) P I.Med. 803.
   s. Rheumatology (4-6) P I.Med. 803.
   u. Clinical Endocrinology, Metabolism and Hypertension (3-6) II P, completion of required third year Internal Medicine clerkship.

891. Preceptorship
a. General Medicine and/or Subspecialties (3-12) [Rpt./2]
   b. Ambulatory Internal Medicine: Clinical Problems (6)
   d. Cardiology (3-8) P, fourth year medical students.
   e. Hematology/Oncology (3-8) P, 803.

896. Seminar
a. Pathophysiology and Immunology of the Clinical Manifestations of Coccidioidomycosis (2) II

Microbiology and Immunology
See Microbiology and Immunology elsewhere in this catalog.

Molecular and Cellular Biology
See Molecular and Cellular Biology elsewhere in this catalog.

Neurology (NEUR)

Professors Alan B. Rubens, Head, Carol Barnes (Psychology), Peggy Ferry (Pediatrics), Mary I. Johnson (Anatomy, Pediatrics), William A. Sibley
Associate Professors Colin R. Bamford, Erwin B. Montgomery, Johan Van Dalen (Ophthalmology), Gary Wenk (Psychology)
Assistant Professors Geoffrey L. Ahern (Psychology), Mary I. Johnson (Anatomy, Pediatrics), Ponjola Coney, Diane S. Sobonya

595. Colloquium
   y* Introduction to the Neurosciences I (2) 1991-92 P Consult department before enrolling. (Identical with Med. 595y, which is home)
   z* Introduction to the Neurosciences II (2) 1991-92 P, 595y or consult department before enrolling. (Identical with Med. 595z, which is home)

*May be convened with 400-level course.

800. Research (1-12) [Rpt./1] (See College of Medicine Electives Manual)

803. Clinical Clerkship (3-6)

805a-805b. Human Neuroscience (6) I II (Identical with Anat. 805a-805b)

810. Clerkship
a. Neurology (3-6)

815. Subspecialty
a. Clinical Infertility (4-6) II S
   c. High Risk Obstetrics (4-6) P, core Ob/
   Gyn rotation completed.

891. Preceptorship
a. Obstetrics and Gynecology (1-18)
   b. Gynecology-Endocrinology (6)
   c. Reproductive Endocrinology and Fertility (4-6) P, core Ob/Gyn rotation completed.
   d. Gynecologic Oncology (3-6) P, core Ob/
   Gyn rotation completed.

Ophthalmology (OPH)

Professor Barton L. Hodes
Associate Professor Johan T.W. Van Dalen
Assistant Professor Robert W. Snyder, Acting Head

800. Research (6-18) II

815. Subspecialty
a. Ophthalmology (3-6)

891. Preceptorship

Pathology (PATH)

Associate Professors James M. Byers III, Ronald B. Schifman
Assistant Professors Naomi E. Rance, Catherine M. Spier

599. *Introduction to Forensic Science: Pathology, Anthropology, Toxicology and Law (2) I II Opportunity for the criminal investigator and attorney with an interest in forensic pathology to better understand the results of trauma, toxic substances and environmental catastrophes. Taught off campus only.

*May be convened with 400-level course.
801. General and Systemic Pathology (10)

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]
b. Anatomic/Clinal Pathology (4-6) P, completion of basic sciences.
c. BNI Neuroradiology (4-6) P, completion of basic sciences.

Pediatrics (PED)


Associate Professors Alan D. Bedrick, Carlos A. Flores, John Hutter, Wayne J. Morgan, Michael J. Schumacher, Elsa Sell, John N. Udall, Jr.

Assistant Professors Richard L. Donnerstein, Roni Grad, Daniela Lax, Thomas R. Lloyd, Marc Ovadia, Jean Wilson

800. Research (1-18) (See College of Medicine Electives Manual)

803. Clinical Clerkship (6)

810. Clerkship
b. Inpatient Pediatrics (6)

811. Subinternship
a. Ambulatory Pediatrics (1-18)
b. Behavioral and Developmental Pediatrics (1-18)

815. Subspeciality
a. Advanced Neonatology (4-6)
b. Pediatric Infections Diseases (3-6)
d. Cardiac Ultrasound Echo and Doppler (4-6)
e. Pediatric Cardiology (4-6)
f. Pediatric Neurology (4-6)
g. Pediatric Hematology/Oncology (4-6)
h. Poison Center (4-6) P, 803.
i. Pediatric Pulmonary (4-6) I II P 803.
j. Clinical Allergy (1-6) (Identical with I.Med. 815I, which is home)
p. Pediatric Endocrinology (4-6)
q. Pediatric Clinical Research in a Cross-Cultural Setting (4-12) P, 803 or I.Med. 803.
s. Pediatric Rural Ambulatory Elective (4) P 803.
t. Child With Complex Chronic Illness (4) P, full third year medical school curriculum including pediatrics.

891. Preceptorship
e. Wards (4) P, 803.
g. BNI Pediatric Neurology (4) P, 803.
h. Critical Care (4) P, 803.

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 J. Gellenberg, Head, Allan Beigel, Richard R. Bootzin (Psychology), Henry W. Brosin, Alfred W. Kaszniazi (Psychology), Mary P. Koss, Allan I. Levenson, John C. Racy, Alayne Yates

Associate Professors Harold S. Arkowitz (Psychology), Diane S. Fordney (Obstetrics and Gynecology), Richard D. Lane, Henry I. Yamamura (Pharmacology)

Assistant Professors Peter J. Attarian (Family and Community Medicine), Iris R. Bell, Shirley N. Faihey, Howard D. Toft

595. Colloquium
d. * Introduction to the Neurosciences II (2) 1991-92 P, none; 595x, which is home

"May be repeated with 400-level course.

800. Research (1-12) (See College of Medicine Electives Manual)

803. Clinical Clerkship (6-9) [Rpt./1]

810. Clerkship
a. Clinical and Community Psychiatry (1-18)

815. Subspeciality
c. Outpatient Psychiatry (4-6) P, 803.
d. Forensic Psychiatry (3-6) I IS P 803.

891. Preceptorship

Radiation Oncology (RONC)

Professors J. Robert Cassady, Head, G. Timothy Bowden, Thomas C. Cetas, Eugene W. Germer, Robert B. Roemer

Associate Professors Anne E. Cress, Daniel L. Gmitro, Robert E. Henry

Assistant Professors Laurie L. Fajardo, George W. Seeley, Evan C. Unger, Walter H. Williams

800. Research (1-6) [Rpt./1]

815. Subspeciality
a. Diagnostic Radiology (4)
b. Nuclear Medicine (1-6)

891. Preceptorship
b. Diagnostic Radiology (4) P, completion of basic sciences.

Surgery (SURG)

Professors Bruce E. Jarrell, Head, Victor M. Bernhard, Philip Carter, Milos Chavpil, Jack G. Copeland, George W. Drach, Eric P. Gall (Family and Community Medicine, Internal Medicine), Theodore J. Glattke (Speech and Hearing Sciences), Noel D. Matkin (Speech and Hearing Sciences), Harvey W. Meislin, Michael J. Pitt (Radiology), Charles W. Putnam, Arthur B. Spetzler, Thomas H. Stanisic, Charles M. Tipton (Exercise and Sport Sciences), Hugo V. Villar, Robert G. Votz, Charles L. Witte, Marilyn H. Witte, Charles F. Zukoiski

Assistant Professors James B. Benjamin, Michael J. Esser, Allan J. Hamilton, Stanley P.L. Leong, Leigh A. Neumayer, Daniel W. Spalte, Terence D. Valenzuela, David B. Van Wyck (Internal Medicine), Fred C. Williams, Jr.

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)

811. Subinternship
 a. Emergency Medicine (4-6) P, 815L.
 b. BNI Neurological Surgery (4-6) P, fourth year medical students.

815. Subspecialty
 a. Urinary Stone Disease (6)
 b. Cardiothoracic Surgery (6)
 c. Neurosurgery (6)
 d. Surgical and Medical Problems in Fluid and Electrolyte Balance (1-3) [Rpt/1]
 e. Urology (6)
 f. Orthopedics (3)
 g. Cardiovascular Physiology and Rehabilitation (1-2)
 h. Lymphvascular System in Health and Disease (6 to 12)
 i. Otorhinolaryngology (3)
 k. Sports Medicine (Section of Orthopedic Surgery) (1-6) [Rpt/1]
 l. Orthopedic Bioengineering (3-6) P, Nine weeks of surgery clerkship, 803 and/or 807.
 m. Trauma (3-6)
 n. Spinal Cord Injury (3) Open to majors only, P, senior standing.
 o. Surgical Critical Care (3-6) [Rpt.] P, 803.
 p. Pediatric Orthopedic Surgery (3-6) [Rpt./6 units] P, rotation in pediatrics and orthopedic surgery.
 q. Plastic Surgery (3-4) I P, senior in medical school.
 r. Clinical Experience in Rehabilitation Medicine (1-4)
 s. Vascular Clinical Management (4-8) [Rpt./8 units] P, completion of junior and senior rotations in surgery.
 t. Emergency Medicine (3-12)
 u. Head and Neck Surgery (4-6) P, completion of required clerkships.
 v. Clinics in Medical Ignorance (3-4) II P, junior standing.
 w. Pediatric Urology (4) I II

891. Preceptorship
 a. Surgery and Subspecialties (1-18) [Rpt./3]
 c. General Surgery "B" (4-12) P, 803.
 d. General Surgery "C" (4-12) P, 803.
 e. Care of the Trauma Victim (4-8) P, fourth year medical students or completion of 803.
 g. Research Techniques in Orthopedic Surgery (4-8) P, 803.
 h. Vascular Surgery (4-8) P, fourth year medical students or completion of 803.
 i. Burn Care (4-8) P, fourth year medical students or completion of 803.
 j. Pediatric Orthopedic Surgery/Children's Reconstructive Services (4-6) P, completion of basic sciences.

896. Seminar
 a. Medical Ignorance (2) [Rpt.] II

Medieval Studies
Social Sciences Building, Room 121
(602) 621-1586

Committee on Medieval Studies (Graduate)
Professors Jonathan Beck (French and Italian), John Boe (Music), Sigmund Eisner (English)
Associate Professors Alan E. Bernstein, Chair (History), Richard C. Jensen (Classics), Peter Medirigil (English)
Assistant Professor Albrecht Classen (German)

The Graduate Committee on Medieval Studies does not offer any major at this time. Programs constituting appropriate minors are available for doctoral students with majors in other disciplines. Students interested in the medieval studies minor must seek the approval of the committee in advance.

The program of study for the Doctor of Philosophy minor in medieval studies requires a minimum of fifteen hours in graduate course work (note that no course may serve a student for both the major and minor); a reading knowledge of either classical or medieval Latin; knowledge of an old form of one language (for language majors, this requirement is in addition to the major field); a course in medieval history or culture such as art (for non-art majors), music (for non-music majors), or philosophy (for non-philosophy majors).

Related Courses
Refer to the appropriate department for course descriptions and unit values. Courses which are applicable to the program* are Art History 412A-412B, 413A, 512A-512B, 596C; Lat. 401; Eng. 426, 427, 527A-527B, 596A; Ger. 400A, 511, 520, 696A; Hist. 405A-405B, 406, 407A-407B, 408; Mus. 500A, 503; Span. 402, 422, 520, 696A, 696C; Ital. 422, 696A; Port. 422, 696A; Span. 400A, 422, 541, 620, 696A, 696B; Russ. 583.

* A maximum of six units of 400-level course work may be used in the doctoral minor.

Metallurgical Engineering
(See Materials Science and Engineering)

Meteorology
(See Atmospheric Sciences)

Microbiology
(See Microbiology and Immunology)

Microbiology and Immunology (MICR)
Graduate Program
Arizona Health Sciences Center
Room 6103
(602) 626-6061

Professors John J. Marchalonis, Head, Harris Bernstein, Charles P. Gerba (Nutrition and Food Science), Evan M. Hersh (Internal Medicine), Junetsu Itow, Wayburn S. Jeter (Pharmacology and Toxicology, Emeritus), Marguerite M.B. Kay, Rein Kilkenn (Physics), Henry Koffler (Biochemistry, Molecular and Cellular Biology), Peter P. Lodovici (Emeritus), William Meinke, George B. Olson, Kenneth Ryan (Pathology), John Spizizen (Emeritus), Irving Yall (Emeritus)

Associate Professors Dominick DeLuca, Richard Friedman, David T. Harris, Robert J. Janssens, Norval A. Sinclair, James T. Siski

The graduate program in microbiology and immunology offers research opportunities in all major areas of microbiology and immunology. The research systems used include viruses, viroids, bacteria, bacterial plasmids, fungi, protozoans, parasites, cell and tissue culture, and animal models standardly used in immunological studies.

The department offers the Master of Science and Doctor of Philosophy degrees with a major in microbiology and immunology.

Applicants are required to submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Scores in an advanced section are recommended. At least two letters of recommendation are required for both the M.S and Ph.D programs.

501. Medical Microbiology (6) I The biological characteristics of microorganisms of importance in human health and disease; the reaction of the host to infectious agents and the mechanisms of host defense; diagnosis and management of infectious disease. Lectures, discussions, and laboratory experiments. P, Chem. 241b, Boc. 501.

503R.* Biology of Animal Parasites (3) I (Identical with V.Sc. 503R)

503L.* Parasitology Laboratory (1) I (Identical with V.Sc. 503L)

505. Eukaryotic DNA Replication (3) [Rpt/1]
I 1992-93 (Identical with C.Bio. 505)


520L.* Pathogenic Bacteriology Laboratory (2) II Isolation and identification of pathogenic
bacteria; techniques in pathogenic bacteriology. P, 420R or CR. (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)


527R.* General Mycology (3) I General mycology, with emphasis on the microfungi. P, 205.

527L.* General Mycology Laboratory (2) I General mycology laboratory, with emphasis on the microfungi. P, 527R or CR.

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)

529.* Introductory Virology (3) I Essential features of viruses, and their relationships to the diseases of humans, other animals, plants and microorganisms. P, 205, Chem. 241b, 243b.

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)

538.* Ecology of Infectious Disease (3) II (Identical with V.Sc. 538)

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

545. Advanced Soil Microbiology (2) II 1992-93 (Identical with S.W. 545)

550R.* Medical Mycology (2) II The isolation and identification of fungi of medical importance. P, 205. (Identical with V.Sc. 550R)

550L.* Medical Mycology Laboratory (2) II Laboratory experiments dealing with isolation and identification of fungi of medical importance. 6L. P, 205. (Identical with V.Sc. 550L)

*Might be conveyed with 400-level course.


570. Molecular Genetics (3) I 1991-92 Molecular genetics and biology of the bacterial viruses; molecular mechanisms of gene regulation, DNA replication, DNA repair, mutation and genetic recombination; recent research in bacterial genetics (lysogeny, transduction, conjugation, use of transposons and gene fusions in genetic analysis and transformation); introduction to gene cloning and its use in analysis of gene structure and regulation. (Identical with Gene. 570)


582. Immunotoxicology (2) II (Identical with Tox. 582)


595. Colloquium d. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with C.Bio. 595d, which is home)

596. Seminar a. Current Problems in Molecular Biophysics (1) I II (Identical with Phys. 596a, which is home)

630. Experimental Methods for Research (4) II Hands-on techniques necessary for pursuing a research career in Microbiology and Immunology. 12L. P, 419, 501, 560 or 561, Bioc. 460. Consult department before enrolling. (Identical with V.Sc. 630)

672. Food Safety (2) I 1991-92 (Identical with N.F.S. 672)


891. Preceptorship a. Microbiology and Immunology (3-12) [Rpt./12 units]

Mineral Economics
(See Mining and Geological Engineering)
candidates give serious consideration to developing communication skills in a foreign language.

There are specific course requirements for both the master's and the doctor's degrees in all three majors. These requirements along with other policies and procedures are contained in "Guide to Graduate Study," which is available on request from the Department of Mining and Geological Engineering.

**Geological Engineering (GEN)**


505. Applied Multispectral Imagery (3) II Application of image processing to mineral exploration, engineering geology, groundwater location, and pollution monitoring. P. 407. (Identical with Geos. 505) Glass

507.* Photogeology (3) I Use of aerial photographs in geologic mapping. 1R, 6L. P. Geos. 321. (Identical with Geos. 507) Glass

515.* Rock Excavation (3) II (Identical with M.E. 515)

516.* Field Studies in Geophysics (3) II S Seismic, magnetic, electrical, and gravity exploration techniques. Field trips. Special fee may be required. P. 448 or 421 or 548 or 521. (Identical with Geos. 516) Sternberg

522. Well Logging Interpretation (3) II Basic well logging theory. Fundamentals of quantitative formation evaluation. Detailed investigation of aspects of well logging applicable to student's research interests. P. consult department before enrolling. (Identical with Geos. 522 and H.W.R. 522) Sternberg


525.* Geotechnical Investigations (3) II Investigation and analysis of geologic factors in the design and construction of engineering projects. 1R, 6L. Glass

526a-526b.* Health and Safety in Mining (1-3) I (Identical with M.E. 526a-526b)

527.* Geomechanics (4) I (Identical with M.E. 527)

537. Developments in Rock Mechanics (2) I (Identical with M.E. 537)

545.* Fundamentals of Geostatistics (3) [Rpt/.6 units] II (Identical with M.E. 545)

548.* Geophysical Exploration and Engineering (4) I Principles of gravity, magnetic, and electrical exploration; acquisition and interpretation of data to define geologic structure and evaluate resources. 3R, 2L. P. Phys. 110, 116, Math. 223. (Identical with Geos. 548) Chase/Sternberg


550. Earthquake Engineering (3) I Applied course in earthquake causes and effects, integrating the fields of seismology, engineering, and seismic geology. P. Math. 254. Glass

557.* Fundamentals of Geomechanics (4) II (Identical with M.E. 527)

560. Electrical Exploration Methods (3) I Electrical properties of minerals and rocks, resistivity and resistivity exploration, induced polarization and complex resistivity, magnetotelluric methods, and electromagnetic prospecting methods. P. 421, 448. Consult department before enrolling. (Identical with Geos. 560) Sternberg

570.* Computer Methods in Geological Engineering (3) II Use of computers to solve problems in geological engineering, including data bases, computer contouring, map filtering and enhancement, and multivariate analysis of geologic data. P. introductory courses in computer programming, math, and earth science. Poulton/Sternberg

580. The Mechanics of Fracture in Rock and Other Brittle Materials (3) (Identical with M.E. 580)

587.* Design of Exploration Programs (3) II Geologic and economic principles applied to the design of mineral exploration programs and the evaluation and development of prospects. P. 449. (Identical with Geos. 587) Poulton

649. Probabilistic Methods in Geotechnical Engineering (3) II (Identical with C.E. 649)


696. Seminar a. Research (1-3) [Rpt.] II (Identical with G.En. 696a, which is home) b. Advanced Topics in Mineral Evaluation and Risk Analysis (1-3) [Rpt./3 units] II c. Mineral and Energy Policy Analysis (1, 3) [Rpt./3 units] II d. Advanced Mineral Commodity Analysis (1, 3) [Rpt./3 units] II e. Topics in Mineral and Energy Supply (1-3) [Rpt./3 units] II f. Decision Analysis and Operations Research in Mineral Exploration (1-3) [Rpt./3 units] II g. Process Analysis and Costing (1-3) [Rpt./3 units] II

**Mining Engineering (MNE)**


518.* Mine Investment Analysis (3) II (Identical with M.E. 518)

528.* The Non-Fuel Mineral Industries (3) II Reserves, resources, and major products, production technologies, pricing, market structure and practices, industrial organization, consumption trends, recycling, and foreign trade. P. A.Ec. 504.

584. Economics of Fossil, Fissile, and Alternative Energy Sources (3) II Reserves and resources; economics of production, utilization and conversion; externalities, market structure, technical change, pricing and competitive behavior, interfuel substitution. P. A.Ec. 504.


**600. Readings in Mineral Economics (3) II** Selected readings in the economics of mineral resource exploration and exploitation, environmental protection, national mineral policy, world mineral development, and international trade. P. Econ. 361.

650a-650b. Advanced Principles of Mineral Economics (3-3) Risk analysis; optimum production, depletion and exhaustion; productivity and technical change; imperfect competition in mineral markets; resource distribution, trade and mineral policy. P. Econ. 501a or A.Ec. 504.


696. Seminar a. Research (1-3) [Rpt.] II (Identical with G.En. 696a, which is home) b. Advanced Topics in Mineral Evaluation and Risk Analysis (1-3) [Rpt./3 units] II c. Mineral and Energy Policy Analysis (1, 3) [Rpt./3 units] II d. Advanced Mineral Commodity Analysis (1, 3) [Rpt./3 units] II e. Topics in Mineral and Energy Supply (1-3) [Rpt./3 units] II f. Decision Analysis and Operations Research in Mineral Exploration (1-3) [Rpt./3 units] II g. Process Analysis and Costing (1-3) [Rpt./3 units] II

**Mining Economics (MNEC)**


501.* Analysis of Mine Operations (3) I Use of operations research principles and techniques to analyze various problems in mine operations. P. 402 or a knowledge of probability. Harpalani

502.* Probability and Statistical Concepts in Geologic Media (4) I (Identical with G.En. 502)

503. Analysis of Mining Decisions (3) I Use of geostatistics, system simulation languages and computers to analyze various mining decisions related to resource estimation and mine planning. P. 401, 402, 430, Kim

528R.* Advanced Microbial Genetics (3) II Modern concepts of microbial genetics: basic genetic theory, the molecular architecture, biosynthesis and genetic regulation of bacterial cell structure, control of growth and cell division. P. 181, Ecol. 320 or 321. (Identical with Ecol. 528R, Gene. 528R, and Micr. 528L)

528L. Advanced Microbial Genetics Laboratory (2) I Individual research projects within the framework of microbial genetics, with emphasis on the genetic system of Bacillus subtilis. (Identical with Ecol. 528L and Micr. 528L)

543.* Insect Neurobiology (3) II (Identical with Ento. 543)

545. Concepts in Genetic Analysis (3) I Methods of genetic analysis including mutant isolation, genetic and physical mapping, reverse genetics, evolutionary mechanisms, molecular variation and genomic evolution. P. introductory undergraduate genetics course or biology course. (Identical with Bioc. 545, Ecol. 545, and Gene. 545)

550. Topics in Pigment Cell Biology (2) I (Identical with Anat. 550)

555. Molecular Mechanisms of Development (3) II Detailed examination of molecular, genetic and cellular approaches to selected problems in developmental biology. P. 545, 568, or consult department before enrolling. (Identical with Bioc. 555 and Gene. 555)

556.* Developmental Biology (3) I Principles of development. P. 181. (Identical with Anat. 556)

557.* Experiments in Developmental Biology (4) II Experimental analysis of the principles of development. 2R, 6L. P. 456, Chem. 241b. (Identical with Anat. 557)

558. Advanced Subjects in Endocrinology (2) I (Identical with Anat. 558)

560.* Plant Physiology (4) I (Identical with Pl.S. 560)

562. Plant Intermediary Metabolism (3) II 1991-92 (Identical with Pl.S. 562)

564. Plant Growth and Development (3) II 1991-92 (Identical with Pl.S. 564)

566.* Physiology Laboratory (2) II (Identical with Ecol. 566)

567.* Endocrinology (3) II (Identical with Anat. 567R)

567L.* Endocrinology Laboratory (1) I (Identical with Anat. 567L)

568. Nucleic Acids (4) I (Identical with Bioc. 568)

571.* Human Embryology (4) II (Identical with Anat. 571)

*May be convened with 400-level course.

574. Advances in Mammalian Genetics (2) [Rpt./1] 1992-93 (Identical with Bioc. 574)

577. Principles of Cell Biology (4) II (Identical with Anat. 577)

582. Topics in Neural Development (2) II 1991-92 (Identical with Nrs. 582)

583. Topics in Neural Plasticity (2) I 1991-92 Reading and discussion of primary literature on cellular, biochemical, physiological, and structural changes that occur on the adult nervous system. P. a course in neurobiology, consult department before enrolling. (Identical with Anat. 583 and Nrs. 583)

584. Cellular Neurobiology (2) II 1991-92 (Identical with Anat. 584)

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


590. Colloquium a. Topics in Molecular Biology (1) [Rpt./1] II Open to majors only.
b. Topics in Electron Microscopy (2) [Rpt./2] II 1991-92 P. Math. 125b, Phys. 102b or 103b. (Identical with Bioc. 595b)
d. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with C.Bio 595d, which is home)

621. Cellular, Plant, Microbe Interactions (3) II 1992-93 (Identical with Pi.P. 621)

696. Seminar a. Recent Research (1) [Rpt./3] II

761. Laboratory Rotation (3) II I Current techniques for qualitative and quantitative studies. 9L. Open to majors only.

801. Molecular and Cellular Biology (4) I Freshman medical students only.

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**Molecular and Medical Microbiology**

(See Microbiology and Immunology)

**Molecular Biology**

(See Molecular and Cellular Biology)

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**Music (MUS/MUSI)**

Music Building, Room 109
(602) 621-1655


Associate Professors Daniel I. Asia, Eric Becher, Gary D. Cook, Elizabeth Thompson Ervin, Thomas Ervin, Paula Fan, Nancy Ferguson, John R. Fitch, Jeffrey Haskell, Grayson Hirst, Keith M. Johnson, Jerry Kirkbride, Josef Knot, Timothy Kolosick, Carrol McLaughlin, Rodney M. Mercado, Thomas Patterson, Faye Robinson, Jeffrey Showell

Assistant Professors John T. Brobeck, William Dietz, Noehama Fernandez, 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, harp, oboe, organ, percussion, piano, saxophone, 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 in a major in music theory will show evidence of satisfactory competencies in their fields of concentration. There are two minors, one in music with a minimum of nine units and one in a field outside of music, also with a minimum of nine units. German and French are the required languages for this degree. In the event a candidate works in a field of specialization that warrants it, another language, such as Greek, Latin, or Italian, can be substituted for French with the permission of the School of Music Graduate Committee. If the research specialization lies within a computer-assisted field, expertise in that technology can be substituted for French. Applicants for the Ph.D. program in music education will be required to furnish evidence of at least three years of successful teaching or administrative experience in the field of music whether in the public schools or at the college level. Additional details regarding the doctoral program in music education are available from the Director of Graduate Studies in Music. For further information concerning these degrees see Requirements for Master's Degrees/Master of Music and Requirements for Doctor's Degrees/Doctor of Musical Arts and Doctor of Philosophy elsewhere in this catalog.

Applicants are required to audition by personal interview or by submitting a tape recording. Beginning graduate students must take placement tests in music theory and in music history/literature. Doctoral students are not admitted to a particular curriculum until they have passed a qualifying examination administered each semester by the School of Music. Admission is limited to applicants who exhibit superior musical aptitude and training and who show continued growth in their chosen fields of music.

510a-510b.* Pedagogy (2-2) Study of methods and repertory suitable for studio teaching. Open to music majors in their major performance area only.


520a-520b.* Counterpoint (3-3) Practical study of the counterpoint of the 16th (in 520a) and 18th (in 520b) centuries. P. 220b

521. Introduction to Graduate Music Theory (3) I Introduction to graduate analysis with emphasis on the survey of analytical systems as applied to a number of stylistic periods. Both applied to a number of stylistic periods. Both
### 522a-522b. Art Song Repertory (2-2)
1992-93 Class performance of representative selections from the standard repertory of German, Italian, French, Russian and English language art songs; problems of accompaniment, interpretation, style and ensembles. Registration restricted to singers and pianists. Open to majors only.

### 523a-523b. History of the Opera (3-3)
1991-92 Detailed study of the course of opera from its inception by the Florentine Camerata through Berg, Menotti, Stravinsky, Ginastera, Penderecki, Britten and others. Open to majors only.

### 524. History and Literature of Guitar (3)
II 1992-93 In-depth study of the evolution of the guitar, lute, and vihuela, including repertoire, style periods, and composers. Open to majors only.

### 525. History and Literature of the Wind Band (3)
A research-oriented study of wind band history and literature from the Renaissance to the present.

### 526a-526b. Piano Literature (3-3)
Historical and stylistic study of keyboard literature, instruments and performance practices. 526a: Baroque through the early Romantic periods. 526b: Mid-Romantic through the Contemporary periods. P, 285-P 526a is not prerequisite to 526b.

### 528. American Pop Music: Sinatra Era (3)
S American popular music associated with Tin Pan Alley and the American musical theater through the recordings and interpretations of Frank Sinatra.

### 530. Music in the Renaissance (3) II 1992-93 Vocal and instrumental genres from Dufay through Palestrina. Open to majors only.

### 531. Music in the Baroque (3) II 1991-92 The age of the basso-continuo; instrumental and vocal genres from Monteverdi through J. S. Bach. Open to majors only.

### 532. Music in the Classical Period (3) I 1992-93 The Viennese classical tradition from its origins to Beethoven. Open to majors only.

### 533. Music of the Twentieth Century (3) II 1992-93 Contemporary idioms in music; study of genres, styles, and techniques from post-Romanticism to the present. Open to majors only.

### 534. Music in World Cultures (3) II S Overview of nonwestern musics in selected world cultures.


### 537. Survey of Early Music (3) II S Intensive survey of music history from Gregorian chant to the late Baroque. This course may not be used to fulfill doctoral requirements in music. Open to majors only.

### 542.* Electro-Acoustic Studio Resources (3)
I Advanced techniques: synthesis, processing, synthesizer programming, sampling, MIDI, computer-assisted techniques, sequencing and notation.

### 550. Advanced Studies in Music Teaching (3) II S Comprehensive study of planning, organizing and evaluating learning experiences in music for K-12 students.

### 551. Behavioral Research in Music (3) I 1992-93 Research methodologies as they apply to musical behavior; emphasis on applying the results of existing studies to practice and on conducting original research.

### 555.* Music and German Literature (3) I 1992-93 (Identical with Ger. 555) May be convener with 400-level course.

### 560. Aesthetics of Music (3) I Exploration of the problems of musical meanings, including a panoramic examination of what philosophers, musicologists, musicologists, and others of critical intelligence have contributed to comprehensive theory.

### 570. Advanced Conducting (3) [Rpt.] I Styles of choral, band, and orchestral literature, as they pertain to the problems of the conductor; references to the styles of all periods, with emphasis on the contemporary and modern.

### 580. Introduction to Graduate Study in Music (3) I 1992-93 Survey of speculative theory (3-3) Intensive analysis of works written in the larger forms. 621a: 18th century. 621b: 19th century. Open to majors only. 621a is not prerequisite to 621b.

### 582. Theory Pedagogy (3) I 1992-93 Study of the philosophies, procedures, techniques, and materials used in teaching theory at the college level.

### 583. Analysis of Contemporary Music (3) I 1992-93 Study of the philosophies, procedures, techniques, and materials used in teaching theory at the college level.

### 590. Large Conducted Ensembles (1)
- a. Summer Band
- b. Marching Band
- c. Concert Band
- d. Symphonic Band
- e. Wind Ensemble
- f. Summer Chorus
- g. Symphonic Choir
- h. University Singers
- i. University-Community Chorus
- j. Chamber Choir
- k. Choraliers
- l. Symphony Orchestra
- m. Chamber Orchestra
- n. Collegium Musicum
- o. Jazz Ensemble
- p. Honor Choir

### 591. Coached Ensembles (1)
- a. Accompanying
- b. Brass Ensemble
- c. Percussion Ensemble
- d. Guitar Ensemble
- e. Jazz Combo
- f. Saxophone Ensemble
- g. String Ensemble
- h. Woodwind Ensemble
- i. Steel Band
- j. Mariachi Arizona

### 592. Small Conducted Ensembles (1)
- a. Brass Choir
- b. Contemporary Ensemble
- c. Clarinet Choir
- d. Musical Theatre
- e. Pep Band
- f. Flute Choir
- g. Recital Choir

### 605. Organ Theatre (1-4) Training in all aspects of organ performance, including major singing roles, minor roles, opera chorus, opera scenes and chamber opera; technical training in set construction, makeup, costumes and lighting. 605 may also include operatic staging techniques. P, 4 units of 405 or permission of the School of Music.
Composition Studies: Individual and Group Instruction

640. Advanced Composition (2-6 I II [Rpt]) Individual projects in composition. Open to theory and composition majors only.

Performance Studies: Individual and Group Instruction (MUSI)

All of the courses listed below are offered both first and second semester.

See schedule of fees below.

Piano 580-P (1-2); 585-P (1-4); 685-P, 785-P (1-4)

Piano Accompanying 685-W (1-4)

Voice 580-V (1-2); 585-V (1-4); 685-V, 785-V (1-4)

Vocal Coaching 685-J (1)

Organ 580-O (1-2); 585-O (1-4); 685-O, 785-O (1-4)

Conducting 585-Q (1-4); 685-Q, 785-Q (1-4)

String Instruments

String Bass 580-N (1-2); 585-N (1-4); 685-N, 785-N (1-4)

Violin 580-K (1-2); 585-K (1-4); 685-K, 785-K (1-4)

Cello 580-M (1-2); 585-M (1-4); 685-M, 785-M (1-4)

Harp 580-H (1-2); 585-H (1-4); 685-H, 785-H (1-4)

Guitar 580-G (1-2); 585-G (1-4); 685-G, 785-G (1-4)

Viola 580-L (1-2); 585-L (1-4); 685-L, 785-L (1-4)

Harpischord 580-I (1-2); 585-I (1-4); 685-I (1-4)

Wind Instruments

Baritone 580-E (1-2); 585-E (1-4); 685-E (1-4)

Bassoon 580-B (1-2); 585-B (1-4); 685-B, 785-B (1-4)

Clarinet 580-C (1-2); 585-C (1-4); 685-C, 785-C (1-4)

Flute 580-F (1-2); 585-F (1-4); 685-F, 785-F (1-4)

Horn 580-D (1-2); 585-D (1-4); 685-D, 785-D (1-4)

Oboe 580-A (1-2); 585-A (1-4); 685-A, 785-A (1-4)

Saxophone 580-S (1-2); 585-S (1-4); 685-S, 785-S (1-4)

Trombone 580-R (1-2); 585-R (1-4); 685-R, 785-R (1-4)

Trumpet 580-T (1-2); 585-T (1-4); 685-T, 785-T (1-4)

Tuba 580-Y (1-2); 585-Y (1-4); 685-Y (1-4)

Percussion Instruments

Percussion 580-Z (1-2); 585-Z (1-4); 685-Z, 785-Z (1-4)

Music Fees

All students registering for private or group instruction are charged special fees according to the following schedule. Regular and scholar-ship students will be assigned to private or group instruction each semester only after a Music Fee Statement has been secured. Rental instruments, practice rooms and lockers are issued upon presentation of this statement.

Group lesson or one-half hour private lesson: $40.

One-hour private lesson: $60.

A music major registering for more than one weekly lesson will pay a maximum fee of $60.

Rentals

Instruments are rented as available for use in regularly scheduled music activities according to the following fee schedule. Any damage beyond normal wear and tear will be paid for by the renter of the instrument. All rental instruments must be returned by the end of the semester or on demand.

Practice Room and Piano Rental: Pianos will be rented only to those enrolled in group, private instruction or keyboard classes. $5 for one hour practice per day. $10 for two hours practice per day. $15 for three hours practice per day.

Organs, Harpsichords, and Synthesizers: $10 for one hour practice per day. $15 for two hours practice per day. $20 for three hours practice per day.

Harp: $20 for one hour practice per day. $25 for two hours practice per day. $30 for three hours practice per day.

Band and Orchestra Instruments: Rental only to those enrolled in ensembles or techniques and literature classes. $10 per semester. Refunds will be made according to the refund schedule. No refund will be made on rental charges of $5 or less.

Music Education (See Music)

Musicology (See Music)

Near Eastern Studies (NES)

Franklin Building, Room 403 (602) 621-9113

Professors William G. Dever, Head, Ludwig A. Adamec, Michael E. Bonine, Adel S. Gaamil, J. Michael Mahar, Hamdi A. Gafisheh

Associate Professors Esther Fuchs (Judaic Studies), William J. Wilson, Assistant Professors Simin Karimi, Senzil Adamec, Michael E. Bonine, Adel S. Gaamil, J. Michael Mahar, Hamdi A. Gafisheh

Assistant Professors Simin Karimi, Senzil Adamec, Michael E. Bonine, Adel S. Gaamil, J. Michael Mahar, Hamdi A. Gafisheh

The department offers programs leading to the Master of Arts degree with a major in Near Eastern studies. The Bachelor of Arts and the Doctor of Philosophy degrees with a major in Near Eastern studies. The Bachelor of arts and the Doctor of Philosophy degrees with a major in Near Eastern studies. Concentrations are available in language and literature, history, thought, and society (either ancient or modern) of these areas. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in Near Eastern studies. For information concerning this degree, see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Applicants must forward to the head of the department scores on the aptitude test of the Graduate Record Examination and two letters of recommendation from previous instructors or academic advisors. Students without previous disciplinary or language training related to the Middle East may be required to make up deficiencies without graduate credit.

Degrees

Master of Arts: Requirements include 30 units of course work with a thesis or, when a departmental paper is submitted in lieu of thesis, no fewer than 32 units. Two degree plans are available in consultation with an advisor: (1) a nonspecialist terminal program, multi-area if desired, and (2) a specialist program requiring a minimum of two years of an appropriate language. The specialist program normally requires three or more semesters and often serves as preparation for the Doctor of Philosophy degree program.

Doctor of Philosophy: This program requires completion of the Master of Arts degree (specialist program) or equivalent training plus those additional courses in the major and minor areas selected by the student's guidance committee.


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) Readings in Persian, with the objective of preparing the student for independent research. 515b: Contemporary prose, 515b: Poetry and prose. P. two yrs. of Persian. 515a is not prerequisite to 515b.

24a-524b. Conversational Levantine Arabic (3-3) Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and comprehension. P. 104a.

25a-525b. Conversational Gulf Arabic (3-3) Extensive oral drill, with emphasis on the acquisition of facility in normal conversation and comprehension. P. 104a.

26. 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.

537b. Readings in Akkadian (3-3) (Identical with Anth. 537a-537b)

539a-539b. Egyptian Arabic (3-3) Introduction to the Cairene dialect. Phonology, common greetings, basic vocabulary and grammar. P. one year of Standard Arabic.
540. Linguistic Change and Diachronic Theory (3) II (Identical with Ling. 540)

542. Transformation of Agrarian Societies in the Middle East (3) II Dynamics, processes, and implications of rural change in the Middle East; focus on changes in peasant communities, nomadic pastoralists, rural-urban relations, and planned change. (Identical with A.Ec. 542, Pol. 542, and Soc. 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 socioeconomic development, with emphasis on determinants and consequences of population growth and migration in contemporary Middle East. (Identical with A.Ec. 567 and Pol. 567)

568a-568b. Asia and the West (3-3) 1991-92 (Identical with Hist. 568a-568b)

570. Religious History of India (3) (Identical with Hist. 570)

572. History of Medieval India (3) I 1991-92 (Identical with Hist. 572)

573. History of Modern India and Pakistan: 1750-Present (3) II 1991-92 (Identical with Hist. 573)

577a-577b. History of the Middle East (3-3) History of civilization in the Middle East from the rise of Islam to the 18th century. 577a: Period of Arab dominance. 577b: Period of Turkish dominance. 577a is not prerequisite to 577b. (Identical with Hist. 577a-577b)

578. Modern History of the Middle East (3) I Near and Middle Eastern history since the late 19th century, with special emphasis on Egypt and areas to the east. (Identical with Hist. 578)

581a-581b. Archaeology of Syria-Palestine in the Bronze and Iron Ages (3-3) Survey of the Bronze and Iron Age cultures of Syria-Palestine, ca. 3500-500 B.C., with emphasis on the use of archaeological materials in historical reconstruction.

584a-584b. Akkadian Linguistics (3-3) (Identical with Anth. 584a-584b)

585. Social Organization of India and Pakistan (3) I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with Anth. 585)

586. Political Systems of India and Pakistan (3) II Survey of post-independence political developments in Pakistan and India. (Identical with Pol. 586)

590. Women in Middle Eastern Society (3) I (Identical with Anth. 590)

592. History of Sufism (3) II (Identical with Hist. 592)

595. Colloquium
  d. Middle East (3) [Rpt.1] II

n. Modern Arabic Prose (3) [Rpt/U] I P. two years of Arabic.
  o. Classical Arabic Prose (3) [Rpt.] I P. two years of Arabic.
  z. Readings in Classical Arabic Poetry (3) S P. three years of Arabic for non-native speakers of Arabic.

596. Seminar
  b. Special Topics in Near Eastern Studies (3) [Rpt./4]
  m. Middle East: Topics in History and Civilization (3) [Rpt.] I II
  q. Near Eastern Archaeology (3) [Rpt.] I II (Identical with Anth. 596q)

*May be convened with 400-level course.

696. Seminar
  b. Cultural Anthropology (1-3) I (Identical with Anth. 696b, which is home)
  i. International Water Resource Management (1-3) [Rpt.] I (Identical with H.W.R. 686i, which is home)

**Neurobiology (See Neuroscience)**

**Neuroscience (NRSC)**

Gould-Simpson Building, Room 401 (602) 621-8380

Committee on Neuroscience (Graduate)

Professors John G. Hildebrand, Chairperson (Arizona Research Laboratories, Division of Neurobiology), A. Terry Bahill (Systems and Industrial Engineering), Carol A. Barnes (Psychology), Bryant Benson (Anthropology), David E. Blask (Anatomy), Richard Bootzin (Psychology), James R. Bloedel (Physiology), Ronald J. Lukas (Pharmacology), Bruce L. McNauth (Psychology), Lynn Nadel (Psychology), L. Claire Parsons (Nursing), William R. Roeseke (Internal Medicine), Alan R. Rubens (Neurology), Joachim F. Seeger (Radiology), Lawrence Z. Stern (Internal Medicine), Nicholas J. Zuccollo (Arizona Research Laboratories, Division of Neurobiology), Douglas G. Stuart (Psychology), Marc E. Tischler (Biochemistry), Arthur Winfree (Ecology and Evolutionary Biology), Henry Yamamura (Pharmacology)

Associate Professors Kathryn A. Bayles (Speech and Hearing Sciences), Janis M. Burt (Physiology), Thomas P. Davis (Pharmacology), Roger M. Enoka (Exercise and Sport Sciences), Laurel A. Fisher (Pharmacology), Edward French (Pharmacology), Ziaul Hasan (Physiology), Alfred W. Kaszniaik (Psychology), David L. Kreulen (Pharmacology), Hugh E. Laird (Pharmacology and Toxicology), Richard B. Levine (Arizona Research Laboratories, Division of Neurobiology, Physiology), Frank Porreca (Pharmacology), Douglas R. Seals (Exercise and Sport Sciences), Linda Swiswer (Speech and Hearing Sciences), Marc E. Tischler (Biochemistry), Leslie P. Tolbert (Arizona Research Laboratories, Division of Neurobiology, Anatomy)

Assistant Professors Edmund A. Arbas (Arizona Research Laboratories, Division of Neurobiology), Gai D. Burd (Anatomy, Molecular and Cellular Biology), William M. Feinberg (Neurology), Ralph E. Fregosi (Exercise and Sport Sciences), Jeannette D. Hoit (Speech and Hearing Sciences), Josephine Lai (Pharmacology), Nathaniel T. McMullen (Anatomy, Neurology), Erwin B. Montgomery, Jr. (Neurology), Naomi E. Rance (Pathology), Linda L. Restifo (Arizona Research Laboratories, Division of Neurobiology, Neurology), Sandra S. Rosse (Pharmacology and Toxicology), Paul A. St. John (Anatomy), Thomas R. Tobin (Arizona Research Laboratories, Division of Neurobiology, Entomology), Gary L. Wenk (Psychology, Neurology)

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 in the doctoral program. The committee comprises faculty members from several departments in the colleges of Arts and Sciences, Engineering and Mines, Medicine, Nursing, and Pharmacy, as well as the Arizona Research Laboratories. The members of the Committee on Neuroscience are the principal faculty of the graduate program and thus may serve as major advisors for students majoring in neuroscience. In addition, the committee fosters research and communication in interdisciplinary neuroscience throughout the University. Areas of expertise of the faculty range from molecular mechanisms of synaptic transmission to human neurological disorders. Faculty groups focus upon cognitive neuroscience, developmental neurobiology, human speech and hearing, insect neurobiology, neuropeptides, pharmacology, and motor control. Information about the research interests of the faculty can be obtained from the program office.

543. Insect Neuroscience (3) II (Identical with Ento. 543)

*May be convened with 400-level course.

592. Topics in Neural Development (2) I 1991-92. An in-depth analysis of the cellular and molecular basis of neural development. Students will read and discuss journal articles dealing with the development of neurons and their synaptic connections. P. consult program office before enrolling. (Identical with Anat. 582, M.C.B. 582 and Psio. 582)

583. Topics in Neural Plasticity (2) I 1992-93 (Identical with M.C.B. 583)

584. Cellular Neurobiology (2) II 1991-92 (Identical with Anat. 584)

588. Principles of Cellular and Molecular Neurobiology (4) I Detailed introduction to the
Nuclear and Energy Engineering (NEE)

Engineering Building, Room 200
(602) 621-2551

Professors: Steven C. Crow, Acting Head, William Filipone, Barry D. Ganopol, David L. Hetrick, Robert L. Seale, Roy G. Post (Emeritus), Morton E. Wacks
Associate Professor Rocco A. Fazzolari

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in nuclear engineering. These programs prepare the student for advanced study and research in various applications of nuclear energy including the analysis and design of fission and fusion reactors, the dynamics of nuclear systems, the interaction of radiation with matter, nuclear safety, energy systems analysis, and management, nuclear fuel cycle evaluation, and the many specialized uses of isotopes. Master's degree students may select one of the following interdisciplinary options: biomedical engineering or energy systems engineering. For details concerning these options, see Engineering elsewhere in this catalog.

The applicant should have completed the equivalent of the undergraduate major in nuclear engineering, but liberal substitutions are allowed for those with undergraduate majors in mathematics, physics, chemistry, or other engineering disciplines.

For the Master of Science degree a thesis is required of all students except those working in the energy systems engineering option.


506. Nuclear Engineering Laboratory (3) I II Experimental techniques for determining various parameters in nuclear systems; experiments using the critical and subcritical reactors. P. 380 or 588.

507. Radiochemistry and Radiation Detection (3) I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. P. Chem. 480b or Phys. 330. (Identical with Chem. 507)

514.* Energy System Design (3) II Modern engineering design methods to effectively use thermal energy and power. Covers: economic analysis and modeling of thermal equipment; optimization techniques; steady state and dynamic simulation of energy systems. Comprehensive project. CR, A.M.E. 432.

540.* Energy Utilization and Management (3) I Methods for evaluating the technical and economic aspects of energy conversion and usage directed toward the effective utilization of resources, including economics, HVAC systems, electric power, lighting and industrial processes.

541. Industrial Energy and Power Management (3) I Analysis of effective energy utilization in industrial operations: availability analysis, combustion, heat recovery, process energy, building systems, cogeneration, electrical loads, lighting and machinery.

542.* HVAC System Design (3) I Analysis and design of air conditioning systems for commercial and industrial buildings, including equipment and component selection. Energy-efficient controls, central and computer analysis will be emphasized. P. 441. (Identical with A.M.E. 542)

543. Power Plant Engineering (3) II The application of fluid dynamic heat transfer and mechanical interaction principles to the engineering design of a power plant. P. 582, 588.

545.* Solar Energy Engineering (3) I Energy analyses of active and passive solar collectors; selective surfaces; solar cells; energy storage; systems for solar heating and cooling; mechanical and electrical power: perspective. P. A.M.E. 230.

546.* Photovoltaic Systems Engineering (3) I Presents system performance prediction methods, load estimation, power conditioners, battery storage principles, system design, and qualitative semiconductor device physics.

547. Direct Energy Conversion (3) I Engineering requirements for achieving direct conversion of energy to electrical power; the engineering of thermoelectric and thermionic converters, fuel cells, magnetohydrodynamic, and photoelectric systems. P. Math. 254; A.M.E. 230; or Phys. 121. (Identical with A.M.E. 547 and E.C.E. 547)

556.* Engineering System Simulation (3) II Dynamic modeling and simulation of engineering systems, including energy conversion systems, nuclear and chemical reactors, and control systems, using digital continuous-system simulation languages. P. A.M.E. 230 or Ch.E. 305a; Math. 254.

563. Energy from Biomass (3) II (Identical with A.B.E. 563)


582. Contemporary Nuclear Power Systems (3) I Analysis of present nuclear power plants, with emphasis on design decisions as they affect performance of individual systems; advanced design concepts; proposed standard designs; comparison of different contemporary systems. P. 381 or 486.

583.* Dynamics of Nuclear Systems (3) I Nuclear reactor kinematics, integral transform methods, internal feedback effects, stability and control. P. 380, 588.

584.* Radiation Effects (3) I Radiation effects on solids and radiation chemistry of gases and liquids, with emphasis on effects encountered in nuclear reactor, detector, and dosimetry systems. P. 380, CR, M.S.E. 331R.

585.* Radiation Health Physics and Safety (3) I Study of health physics practices and safety responsibilities; analysis of radiation environments and applications of basic shielding methods to provide understanding of accepted working practices.

586.* Nuclear Energy and Power (3) I Fundamentals of nuclear energy and radiation; engineering applications; the basic concepts of nuclear reactors and power systems. Designed for nonmajors.

587.* Introduction to Radioactive Waste Management (3) I Background in the technology of the management of all types of radioactive wastes from the nuclear fuel cycle, institutions, and industry. *May be convened with 400-level course.


645. Advanced Solar Engineering (3) II Research and development studies related to solar applications: engineering design, analysis, and economics. Course includes invited lectures, literature research, and an original paper. P. 545. (Identical with Ch.E. 645)

660. Fuel Cycles for Nuclear Reactors (3) II 1992-93 The design and analysis of fuel cycles for nuclear reactors; the processes and requirements for fuel element design and the limitations of fuel element performance to reactor design; economic factors in fuel cycles. P. 588.

681a-681b. Analytical Methods of Transport Theory (3-3) 1991-92 Application of the Boltzmann equation to neutron and photon transport problems; exact solutions, the method of singular eigenfunctions, spherical harmonic expansions, the moments methods, integral transport theory, invariant embedding, variational techniques, applications to slowing-down problems. P. 689, Math. 422a-422b.

682. Nuclear Safety (3) II Possible incidents involving nuclear materials in critical reactors, chemical processing systems, fuel shipment operations or subcritical arrays, including assessments of the magnitudes and consequences of nuclear incidents; determination of criteria for evaluating nuclear system safety, including plant siting and operational procedures. P. 380.

683. Nonlinear Reactor Dynamics (3) II Nonlinear dynamics of nuclear reactors; inertial effects, nonlinear stability criteria, time-dependent neutron transport, neutron waves, and applications to pulsed reactors,
687. Experimental Nuclear Engineering (3) I 1992-93 Advanced experimental studies using the nuclear reactor and radiation detection systems. 2R, 3L. P. 406 or 506, 588.

688. Technology of Radioactive Waste Storage and Disposal (3) II Detailed technology of nuclear waste streams, their processing and waste collection, segregation, reduction methods and storage and disposal alternatives for high-level and low-level waste. P. 487 or 587.

689. Reactor Theory II (3) II Fundamental theory of heterogeneous reactors, integral transport, blackness theory, perturbation theory, and applications; temperature coefficient, changes in reactivity due to fission product accumulation, fuel consumption, and conversion. P. 588.

**Nursing (NURS)**

Nursing Building, Room 103  
(602) 626-6161

Professors L. Claire Parsons, Dean, Agnes M. Aamodt (Emerita), Eleanor E. Bawwens (Emerita), Pearl P. Couter (Emerita), Ada Suss Munro (Emerita), Margaret A. Kay, Alice J. Longman, Beverly A. McCord (Emerita), Carolyn Murdaugh, Linda R. Phillips, Arlene M. Putt (Emerita), Gladys E. Rosensten (Emerita)

Associate Professors Evelyn M. DeWalt, Sandra Ferketich, Rose Gerber, Mary E. Hazzard (Emerita), Lillian Lynch (Emerita), Betty J. McCracken (Emerita), Virginia Miller (Emerita), Alice L. Noyes, Jessie V. Pergrin (Emerita), Lois E. Prosser (Emerita), Pamela Reed, Gayle A. Traver, Suzanne Van Ort, Joyce Verran, Mary J. Wety (Emerita), Mary O. Wolsin (Emerita), Anne Woodfill

Assistant Professors Mary Alexander, Terry Badger, Carrie Jo Braden, Leanna Crosby, Joan E. Haase, Lorraine Haertel, Elaine B. Jones, Margaret A. Knight, Nancy Kline Leidy, Ida M. Moore, Christine M. Sheehy, Jacqueline J. Sherman

The College of Nursing offers programs leading to the Master of Science, Nursing Specialist, and Doctor of Philosophy degrees with a major in nursing.

Applicants for all degree programs are required to submit (1) evidence of completion of an undergraduate program in nursing substantially equivalent to the Bachelor of Science in Nursing degree program at the University of Arizona, (2) a current license to practice as a registered nurse in Arizona, (3) references attesting to professional competence, (4) evidence of satisfactory completion of a course in elementary statistics, (5) scores on the aptitude test of the Graduate Record Examination, (6) a statement indicating academic and professional goals as well as research interests, and (7) evidence of skills in physical assessment. In addition, (8) computer literacy is required.

An automobile is essential since the clinical facilities are located throughout the Tucson area.

**Degrees**

**Nursing Specialist:** For information concerning this degree program see Requirements for Specialist Degrees/Nursing Specialist elsewhere in this catalog.

Applicants to the graduate program must present evidence of the completion of a bachelor's degree or both bachelor's and master's degrees substantially equivalent to those nursing programs at the University of Arizona. Admission is based upon the evaluation of the following criteria: undergraduate cumulative grade-point average of at least 3.00 or "B" graduate grade-point average of 3.50, Graduate Record Examination scores of 1,100 on the quantitative and verbal portions of the aptitude test. In addition, applicants must submit references attesting to their potential as graduate students. A personal interview is encouraged. The major purpose of the program is the preparation of the clinical nurse researcher.

The College of Nursing graduate program is planned for four years and 108 units of graduate 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 a thesis and graduate with 36 units. Students progressing directly through the doctoral program are not required to complete a master's thesis.

**504. Conceptual Models (3)** I S Theory and research surrounding conceptual models with emphasis on description of conceptual models.

**521. Nursing Care of the Child with a Handicap or Chronic Illness (3)** I Overview of congenital and acquired handicaps or chronic conditions in school age children. Assessment and management in the school setting of these children and their families. Open to majors only. P. 481, or consult college before enrolling.

**522. School Nursing Practice (3)** I Analysis and application of nursing in school systems. Program development and evaluation, health curriculum development, and principles of epidemiology for identification of high risk groups. Open to majors only. P. 481, or consult college before enrolling.

**530. Methods in Nursing Research (3)** II Critical examination of selected problems and methods in the nursing research process. Consideration is given to both qualitative and quantitative methods.

**580. Principles of Physiology in Health Care (4)** I Selected physiologic functions and adaptive changes which occur in health and illness. Cellular physiology, the immune system, neurophysiology, cardiovascular, pulmonary, renal, and endocrine physiology. P. undergraduat e physiology.

**583. Perspectives of Cancer Care for Health Professionals (3)** I Current methods for cancer care for individuals with cancer and their families. 6R, 9L. Not accepted in doctoral program of study in nursing. P. enrollment in baccalaureate or graduate programs in nursing or pharmacy. (Identical with Ph.Pr. 583)

**587. Poverty and Health (3)** I Study of the relationship between poverty and health. Concepts and theories from anthropology, psychology, and sociology will be used to analyze problems associated with poverty. Advanced degree credit available for non-Ph.D. majors only. P. six units of social science. (Identical with Anth. 587 and F.C.M. 587)

**588. Clinical Anthropology (3)** I Application of principles from anthropological theory to the actual practice of patient care, with emphasis on cultural content of groups living in the greater Southwest. P. nine units of behavioral sci. (Identical with Anth. 588 and F.C.M. 588)

**589. Health of the Older Adult (3)** I Current research of the aging process including physical and mental alterations; emphasis on physiological changes. Consult college before enrolling. (Identical with Gero. 589)

**595. Colloquium a.** Bilingual Health Communication (3) II (Identical with Anth. 595a, which is home.)

*May be convened with 400-level course.

**600a-600b. Nursing Theory and Practice (3-3)** I S I S Maintenance, therapeutic and preventive nursing care of persons in various settings. Student elects practice in one area of nursing: 600a (I) is selected for (1) child, (2) maternal-newborn, or (3) psychiatric-mental health. 600b (II) is chosen for (1) community health, (2) gerontology, (3) medical-surgical.

**601. Pathophysiologic Alterations (3)** I Alterations in physiologic mechanisms secondary to alterations in perfusion, oxygenation, hydration, osmolarity, temperature, and resistance to infection. P. 580 or 3 hours of graduate-level physiology.

**603. Public Health Science (3)** I Health promotion and primary prevention in communities and populations, epidemiology and legal/political issues in advanced public health nursing. Nursing and public health theories synthesized. Open to majors only.

**604. Developmental Concepts in Nursing (3)** I Examination of concepts of development over the life span and their relationship to nursing phenomena. Different models or views of development are explored and applied to nursing theory development, research, and practice. Open to majors only.

**605. Issues in Family Relations (3)** I Examination of issues in providing care to families using theory and research from nursing and related fields. Concepts included will apply to the young, developing, and mature family. Open to majors only.

**606. Social, Psychological Problems in Nursing (3)** I Focus on concepts of stress and training with emphasis on health-related outcomes. Nursing research on addictions, depression, abuse and violence will be explored. Open to majors only.

**607. Cross-Cultural Nursing (3)** I 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.

**608. Cognitive Alterations (3)** I Client problems related to the processing of sensory information including etiological factors. Research-based nursing interventions for clients with cognitive alterations are examined. Open to majors only.
621. Educational 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.

622. Nurse Educator Role (3) II 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. P 621.

623. Clinical Agency Administration (3) II Practical application of administrative processes in a nursing care delivery setting. Focuses on the use of selected skills essential to effective administration. Open to majors only. P 624.

624. The Administrative Process (3) I Theoretical background for nursing administration in care settings. Emphasizes on accountability, budgeting, management skills, constraints and influences as related to nursing administration. Open to majors only. P 625.

625. Geriatric Nurse Practitioner Role (3) I Exploration of models of advanced nursing practice role in health care system. Emphasizes factors that influence process of defining and implementing geriatric nurse practitioner role. Open to majors only. P 580.

626. Geriatric Nurse Practitioner Role Development (3) II Focuses on concepts and skills needed to manage therapeutically the common acute and chronic health problems prevalent in older adults. Emphasizes clinical decision-making in abnormal aging. Open to majors only. P 625.

627. Research Utilization (3) S Development and use of models and tools for facilitating the use of research in science-based nursing practice within organizational settings. 2R, 3L. P 530.

633. Evaluation Research (3) I Development and use of models and tools for assessing nursing processes, programs and performances. Approaches to and psychological reactants of evaluation are explored. Issues and development of market packages with cost consideration are discussed along with program grant preparation.

705. Nursing Metathory (3) I Logical testing of theories in practice; history of nursing theory development related to basic epistemology, history, and philosophy of science; alternate meta-theoretical structures, clinical theory development strategies; provision for an exercise in theory construction. Laboratory is required. P, 6 units of clinical specialty or clinical elective, 3 units of advanced human physiology, 3 units of social science at an advanced level.

706. Middle Range Theory (3) II Introduction to ways of knowing, focus on middle range theories in nursing and related sciences. Emphasis on critique, elaboration and theory testing strategies. Open to majors only. P 705.

724a-724b-724c. Professional Role Development (1-1-1) I II Assist student socialization into the role of nurse scientist. Ethics of research, development of grant proposals, dissemination of scholarly work through publication and presentation, balancing roles of scholar, educator and clinician. Open to majors only. P, admission to Ph.D. program.

725. Study of Social Influences (3) S In-depth examination of social forces affecting the health care system. Open to majors only. P, admission to Ph.D. program.

730. Quantitative Methods in Clinical Nursing Research (3) I Investigation of selected quantitative strategies appropriate to research in clinical nursing. Open to majors only. P 530, 633, admission to Ph.D. program.

731. Qualitative Methods in Clinical Nursing Research (3) I Application of selected qualitative research methods from the social sciences to clinical nursing. Open to majors only. P 530, admission to Ph.D. program.

781a-781b. Instrument Construction (3-3) S Deductive and inductive processes for constructing/testing instruments to measure nursing care interventions/patient outcomes. 781a: Instrumentation for behavior and objective phenomena. 781b: Instrumentation for subjective phenomena. Includes instrument strategies; experience developing a pilot measure. 2R, 3L. Open to majors only. P 705, 730, graduate level statistics. 781a is not prerequisite to 781b. (781a and 781b offered alternate summers.)

782a-782b-782c. Field Work In Nursing Research (3-3-3) S I II Individualized course of study incorporating research and clinical knowledge in a selected area of nursing practice in the laboratory and field setting. P 530, 600a-600b, 633, 705, 730.

Nutrition (See Nutrition and Food Science, and Nutritional Sciences)

Nutrition and Food Science (NFS)

Shantz Building, Room 309 (602) 621-1187


The department offers programs leading to the Master of Science degree in food science, nutritional sciences, and dietetics. Graduate study prepares students for careers in academia, health care, industry and government. The department also participates through the Committee on Nutritional Sciences in programs leading to the Doctor of Philosophy in nutritional sciences. (See Nutritional Sciences in the following section).

Prerequisites for admission include: for the M.S. in food science: one semester each of analytical chemistry with lab and microbiology with lab, one year (or its equivalent) each of physics, general biology, organic chemistry with lab and math (calculus recommended); for the M.S. in nutritional sciences: one semester of analytical chemistry with lab, one year each (or its equivalent) of physics, organic chemistry with lab, biochemistry and physiology, and math (calculus recommended); for the M.S. in dietetics: completion of an ADA-approved Plan IV undergraduate program.

Graduate students must complete at least 30 units including an approved thesis to receive the M.S. in food science, nutritional sciences, or dietetics. Students are encouraged to select an advisor and two additional faculty members for their graduate committee as soon as possible, but no later than their second semester. The program of study must include N.F.S. 520 or N.F.S. 540 or N.F.S. 558: 2 units of N.F.S. seminar; 1-6 units of thesis; one unit of N.F.S. 559a; 6 units of N.F.S. 500-600-level electives; 3 units of statistics; 4 or more units of biochemistry; one or more units of 500-600-level laboratory; and 4 or more units of electives.

520. Advanced Nutritional Science (3) I Advanced physiology and biochemistry of nutrients with emphasis on present knowledge and current research topics in nutritional sciences. P, Bioc. 460 or 462a.

538. Problems in the Biochemistry of Aging (2) I 1991-92 Current topics in the biochemistry of mammalian aging; examination of the metabolic, hormonal, immunologic and neural aspects of aging in lower mammals and humans. P, one year biochemistry. (Identical with Gero. 538)

540. Advanced Dietetics (3) I Nutrition and metabolism in patient care as applied by the advanced-level practitioner. Open to majors in nutritional sciences only.

541.* Therapeutic Nutrition (4) II Therapeutic principles of nutrient acquisition and utilization, including modification of the diet, for selected disease and/or deficiency states; factors of importance in client/patient care, rehabilitation and education. P 408.

547.* Perspectives in Geriatrics Laboratory (1) I I (Identical with Ph.Pr. 547)

548. Nutrition in Sport and Exercise (3) II S (Identical with Ex.S.S. 548)

558. Advanced Food Science (3) I Food safety evaluation, microbiology of pathogens and beneficial organisms, chemistry, engineering, processing; analytical chemistry; laws, regulations. P, Chem. 241a-241b, 322; Micro. 317; Phys. 102a-102b; Math. 117R/S.

559.* Sensory Evaluation of Food (3) II 1991-92 Fundamentals of taste, odor, color, and rheology perception as related to food; design and methodology of small-panel and consumer-panel testing. 2R, 3L.
560. Advanced Food Chemistry (3) I 1991-92
Chemical and physical structure and functions of food constituents, additives, and food properties. P, 360, one year of biochemistry.

563.* Food Analysis (3) II 1992-93
Laboratory procedures for chemical and physicochemical analysis of food products. 1R, 6L, P, 360. (Identical with An.S. 563)

565.* Food Engineering (3) II 1992-93 (Identical with A.En. 565)

566. Postharvest Physiology (1) I 1991-93
(Identical with Pl.S. 566)

568. Nucleic Acids (4) I (Identical with Bioc. 568)

570.* Food Microbiology and Sanitation (3) II 1992-93
Microbiology in processing and handling of foods; relation of microorganisms, insects, and rodents to design and function of processing and handling equipment. P, Mirc. 317.

571.* Food Microbiology and Sanitation Laboratory (2) II 1992-93
Laboratory procedures for assessment of sanitary quality of foods. P, 470 or CR.

*May be convened with 400-level course.

572. Food Laws, Standards, and Regulations (2) II 1992-93
Laws, standards, and regulations governing food marketing in the United States; emphasis on food safety, inspection procedures, additives, nutritional labeling and regulatory agencies. P, 6 units from the following: 468, 470; Mktg. 470.

580. Composition and Structure of Meat (2) I 1992-93 (Identical with An.S. 580)

594. Practicum
a. Instruction Techniques in Nutrition and Food Science (2) [Rpt./4 units] II Open to N.F.S. and Nu.Sc. majors only. P, 595a.

595. Colloquium
a. Instruction Techniques in Nutrition and Food Science (1) I

596. Seminar
n. International Nutrition (2-3) II (Identical with F.C.M. 586n, which is home)


602. Metabolic Integration (3) III 1992-93
Food intake, transport, protein and amino acid utilization in higher animals. P, 408.

609. Nutritional Biochemistry Techniques (3) II Biochemical methods for evaluating metabolic functions of nutrients. 1R, 6L, P, 408, Chem. 324 or 325, and 323 or 326. (Identical with An.S. 609)

615. Chemistry and Metabolism of Lipids (3) II 1991-92
Chemistry and structure of lipids and their digestion, adsorption, transport and utilization; current research in lipid metabolism and the role of lipids in certain disease states. (Identical with An.S. 615)

620. Vitamins (2) I 1992-93
The chemistry and metabolism of vitamins. P, 408.

622. Mineral Metabolism (2) I 1992-92
Chemistry, metabolism and biological function of minerals; current research in mineral requirements and toxicity. P, 408. (Identical with An.S. 622)

628. Steroid and Lipoprotein Chemistry and Metabolism (2) II 1992-91
Chemistry and metabolism of mammalian sterols and lipoproteins; biosynthesis and metabolism of sterols and lipoproteins in health and disease; the role of diet in treating abnormalities of sterol and lipoprotein metabolism; sterols and disease. P, 408.

630. Developmental Nutrition (3) III 1992-93
Role of nutrients in development and growth; changes in maternal and child nutritional requirements due to development and growth; current research in developmental nutrition. P, 408.

640. Field Methods in Human Nutrition (3) III 1991-92
Case-oriented approach to nutritional assessment, diagnosis, prescription, plan and prognosis; application of dietary, clinical and biochemical methods. 2R, 3L. Open to majors in nutrition and food science and other health sciences areas only.

663. Chemistry of Food Carbohydrates (2) II 1992-93
Chemical and physical properties of carbohydrates important to their presence in food. P, Bioc. 460, 462a.

665. Chemistry of Food Proteins (3) III 1991-92 (Identical with An.S. 665)

672. Food Safety (2) I 1991-92
Significance and control of foodborne hazards associated with pathogenic microorganisms, microbial toxins, industrial chemicals, and other environmental contaminants. P, 471, Chem. 241b. (Identical with Micr. 672)

693. Internship
a. Dietetic Internship, ADA Accredited (1-6) [Rpt./2] II Field trips. Begins Mid-August and continues for 46 weeks. Consult dept. before enrolling. Open to majors only. P, Course work equivalent to American Dietetic Association Plan IV.

696. Seminar
b. Nutrition (1) [Rpt./6 units] I (Identical with Nu.Sc. 696b)
c. Food Science (1) [Rpt./6 units] II

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**Nutritional Sciences (NUSC)**

Shantz Building, Room 309
(602) 621-5630

**Committee on Nutritional Sciences (Graduate)**

Professors Bobby L. Reid, Chair (Nutrition and Food Science), David S. Alberts (Internal Medicine), Harris Bernstein (Microbiology and Immunology), Milos Chwapi (Surgery), David L. Earnest (Internal Medicine), Charles Gerba (Microbiology and Immunology), Gail G. Harrison (Family and Community Medicine, Pediatrics, Nutrition and Food Science), J. Mel Haver (Animal Sciences), Mary Ann Kight (Nutrition and Food Science), Otakar Kolodvsky (Pediatrics, Physiology), K.Y. Lee (Nutrition and Food Science), Timothy Lohman (Exercise and Sport Sciences), W.F. McCaughy (Nutrition and Food Science), Donald J. McNamara (Nutrition and Food Science), Thomas McNamara (Family and Community Medicine), George Olson (Microbiology and Immunology), Anthony F. Phillips (Pediatrics), Frank D. Rollins (Nutrition and Food Science), William A. Stini (Anthropology, Family and Community Medicine), C. Brent Theuer (Animal Sciences), Marc E. Tischler (Biochemistry), Ronald R. Watson (Family and Community Medicine), Charles W. Weber (Nutrition and Food Science) 

Associate Professors Ronald E. Allen (Animal Sciences, Allen, Paul (Matrics), Patsay M. Brannon (Nutrition and Food Science), Louise Canfield (Biochemistry), Harinder Garewal (Internal Medicine), Donald V. Lightner (Veterinary Science), Douglas L. Pote (Nutrition and Food Science), Ralph L Price (Nutrition and Food Science), Ronald E. Purs (Family and Community Medicine), Mary. Ann Kight (Nutrition and Food Science), John Lattal, Jr. (Pediatrics)

Assistance Professors Iris R. Bell (Psychiatry), Larry C. Clark (Family and Community Medicine)

The interdepartmental Committee on Nutritional Sciences offers graduate work leading to the Doctor of Philosophy degree with a major in nutritional sciences. Options in nutritional biochemistry, human nutrition (clinical or community), or animal nutrition may be selected within this major. The Committee on Nutritional Sciences represents a group of faculty members located in various departments of the University, who participate in graduate training in all areas of nutrition. Only faculty who are members of this larger group, called the Graduate Group in Nutritional Sciences, may serve as major advisers for students majoring in nutritional sciences. Research direction is available in all areas of nutrition, including nutritional biochemistry, human nutrition, clinical and community nutrition, and animal nutrition.

Undergraduate preparation must include one year of college-level mathematics (calculus recommended) and one year each of general biology, physics, and organic chemistry in laboratory. A semester of quantitative analysis is required for students selecting the options in nutritional biochemistry or animal nutrition. GRE scores for quantitative and verbal tests are requested for admission.

**Degree**

Doctor of Philosophy: The student's course of study will be developed by the student and the 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 (599, 699, 999) and seminar (596, 596) credits will be counted toward requirements for the degree.

A minor may be chosen from a variety of areas including biochemistry, animal physiology, physiology, molecular and cellular biology, ecology and evolutionary biology, food science, anthropology, pharmacology, and chemistry.

605. Methods in Nutritional Research (3) I
Survey of experimental approaches to nutrition
research in the areas of food science, animal nutrition, nutritional biochemistry and human nutrition.

696. Seminar
b. Nutrition (1) I II (Identical with N.F.S. 696b, which is home)

Optical Sciences (OPTI)

Optical Sciences Center, Room 401
(602) 621-4111

Committee on Optical Sciences (Graduate)


Associate Professors Eustace L. Dering, Arthur F. Gmitro (Radiology), George N. Lawrence, Masud Mansuripur, Nasser Peyghambarian, Robert R. Schowengerdt (Electrical and Computer Engineering, Astron Research Laboratories), Robin N. Shack (Electrical and Computer Engineering)

Assistant Professors Raymond K. Kostuk (Electrical and Computer Engineering), Thomas D. Milster, Ewan M. Wright

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 electrooptics, 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 Circuitry Cooperative and the Data Optical Storage Center.

Applicants should hold a bachelor's degree in engineering, mathematics, or physics. In addition to the application materials submitted to the Graduate College, applicants must submit to the Associate Director, Academic Affairs, Optical Sciences Center, University of Arizona, Tucson, Arizona 85721, the following materials: one complete set of transcripts; scores on the aptitude and subject (engineering, mathematics, or physics) tests of the Graduate Record Examination, and at least two letters of recommendation. Normally, students are only admitted to begin their studies in optical sciences during fall semester. The deadline for submission of all application materials is March 1; however, because of the large number of applications received each year, early submission is encouraged to enhance the chances of admission.

Degrees

Master of Science: There is no core curriculum for the Master of Science degree, and students are allowed considerable freedom in planning their study programs. Students may elect either of two options:

Thesis option: A minimum of 32 units of graduate credit in optics or optics-related courses, including 8 units of 910 (thesis) and at least 2 units of optics laboratory courses, and a final oral examination based primarily on the thesis.

Non-thesis option: A minimum of 35 units of graduate credit in optics or optics-related courses, including at least 2 units of optics laboratory courses; demonstrated competence in written communication (either by writing an acceptable Master's Report or successfully completing an appropriate course in technical writing); a final oral examination, based primarily on the subject matter of the courses taken.

In addition, the Master of Science degree may be awarded to prospective candidates for the Doctor of Philosophy degree upon successful completion of the preliminary examination.

Doctor of Philosophy: A core curriculum, including courses 501, 502, 503, 504, 505, 506, 507, 508, and 509 has been developed to help doctoral students prepare for the preliminary examination. These courses are not required, but students are expected to know the material presented in them. There is no foreign language requirement for the Doctor of Philosophy major in optical sciences. Students must include at least two units of optical laboratory courses or provide evidence of equivalent laboratory experience. At the discretion of the committee, doctoral students with majors in other disciplines, may elect a minor in optical sciences. Such students must complete, for the minor, twelve units of course work with a grade of "B" or better in optical sciences or obtain approval for the equivalent in transferred course work. No more than six of these units may be crosslisted with the student's major department (if other than optical sciences).

501. Electromagnetic Foundations of Optics (3) I Gauss's law; Coulomb's law; dipole moment; polarizability; Faraday's law; Maxwell's equations; the wave equation; planar waves; spherical waves; Fresnel's formulas; dipole radiation; magneto-optic effects; electro-optic effects. P, Physics 116, Math. 422b.

502. Introduction to Fourier Optics (3) I Harmonic analysis; linear systems; impulse response; Fourier transform; transfer function; diffraction; image formation; holography; optical data processing. P, Math. 223.

503. First-Order Optical Design (3) I Rays and wavefronts; Fermat's principle; Snell's law; dispersion; systems of plane mirrors; Gaussian imagery; paraxial imagery; paraxial design methods; Delano diagram; introduction to aberrations.

503L. First-Order Optical Design Laboratory (1) I Laboratory in support of 503. P, CR.

504. Introduction to Quantum Optics (3) II Quantum background; interaction of radiation with matter; dipole moments; line broadening; quantization of radiation fields; spontaneous emission; stimulated emission; lasers. P, 501, Phys. 330. (Identical with Phys. 504).

505. Interference and Interferometry (3) III Equations; the wave equations; plane waves; 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.

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 Wave equations; energy flow; polarization; energy bands; energy gaps; optical properties of metals, insulators and semiconductors; measurement techniques; modulators; light-emitting diodes. P, 504.

508. Probability and Statistics in Optics (3) II Probability; random variables; stochastic processes; autocorrelation; Wiener spectrum; noise; applications in photography; atmospheric turbulence; analysis of random data. P, 502.

509. Radiometry, Sources, Materials and Detectors (3) II Radiometry; sources; materials and components for optical systems; imaging and non-imaging detectors. P, 503, 503L.


513L. Optical Testing Laboratory (1) I 1991-92 Laboratory in support of 513. P, CR.

514. Aberration Theory (3) II 1992-93 Aberration theory; geometrical image formation; diffraction; pupil, spread, and transfer functions; random wavefront perturbations; system effects; image evaluation; image processing. P, 506.

517. Lens Design (4) I Fundamentals of optical systems layout and design; exact and paraxial ray tracing; aberration theory; chromatic and monochromatic aberrations. 2R, 6L, P, 506.

524. Optical Data Processing (3) II 1991-92 Inverse filtering; matched filtering; frequency-domain synthesis; the Vander Lugt filter; shadow-casting correlators; OTF synthesis; coded-aperture imaging. P, 505.
527. Holography (3) II 1992-93 Historical background; the Gabor hologram; the hologram as a zone plate; Fresnel, image, Fourier-transform, and reflection holograms; practical holography; limitations. P, 505. (Identical with E.C.E. 527)


531. Image Processing Laboratory for Remote Sensing (3) I (Identical with E.C.E. 531)

532. Computer Vision (3) II (Identical with E.C.E. 532)


534.* Electrical and Optical Properties of Semiconducting Materials (3) I (Identical with M.S.E. 534)


540a-540b.* Atomic and Molecular Spectroscopy for Experimentalists (3-3) (Identical with Phys. 540a-540b)

541. Introduction to Lasers (3) I Laser theory; properties of lasers; stimulated emission; dispersion theory; gain saturation and rate equation; optical resonators; survey of laser types and mechanisms. P, Phys. 103b.

541L. Introduction to Lasers Laboratory (1) I Laboratory in support of 541. P, CR, 541.

543. Laser Physics (3) I Density matrix formulation of interaction of radiation with matter; semicircular laser theory; single and multimode single and multimode fields; moving atoms; ring and Zeeman lasers; pressure effects. P, 504. (Identical with Phys. 543)


545. Nonlinear Optics (3) II 1991-92 Scattering of light; parametric amplification; Brillouin, Raman, Rayleigh scattering; stimulated and spontaneous interactions; frequency multiplication; intense field effects; materials damage theory. P, 501.

550. Fundamentals of Remote Sensing (3) I Physics and methodology of remote sensing; radiometry; data collection systems; photointerpretation; photogrammetry; image enhancement and classification; applications in the earth sciences.

558. Radiometry (3) I 1991-92 Units and nomenclature; Planck's law; black bodies; gray bodies; spectral emitters; Kirchoff's law; flux concepts; axial and off-axis irradiance; radiative transfer; normalization; coherent illumination; radiometric instruments. P, 501.

559. Infrared Techniques (3) I 1992-93 The radiant environment; atmospheric properties; optical materials and systems; detector description and use; data processing; displays, systems design and analysis. P, 558.

561. Physics of the Solid State (3) II (Identical with Phys. 561)


566. Optical Detectors (3) II 1992-93 Photoconductors; semiconductors; signal and noise mechanisms; figures of merit; limitations on the sensitivity of detectors; photoemitters; detectors of ionizing radiation. P, 507.

568. Solid-State Imaging Devices (2) I 1992-93 Charge transfer devices; monolithic and hybrid focal planes, figures of merit; time-delay integration; fat zero; transfer efficiency; double-correlated sampling; buried-channel and surface-channel devices. P, 507.

570. Advanced Optical Laboratories (2) II Hands-on experience in current optics research areas. Emphasis is device-oriented. Guided waves; acousto-optics; optical bistability; diode lasers; nonlinear optics; optical phase conjugation. 1R, 3L, P, Phys. 121.


577. Optics of Thin Films (3) II Dielectric interference films; semiconductor and metallic films; planar wave guide films; design methods for multilayer interference filter coatings; thin film components for integrated optical circuits. P, 505.

587.* Fiber Optics Laboratory (3) II Fiber characteristics; fiber preparation; single and multimode fibers; sources; coupling; communication systems; multiplexing techniques; fiber-optic sensors. P, E.C.E. 456. (Identical with E.C.E. 587)

*May be convened with 400-level course.

595. Colloquium a. Current Subjects in Optical Sciences (1) I II


656-656b. Atmospheric Radiation and Remote Sensing (3-3) 1992-93 (Identical with Atmo. 656a-656b)

680. Microcomputer Interfacing in the Optics Laboratory (3) I Design and construction of interfaces between microcomputer systems and a variety of devices in the optics laboratory, including switches, motors, optical sensors, displays and terminals. Hardware and assembly language software drivers. 1R, 6L, P, CSc. 122 or E.C.E. 171.


Oriental Studies
(See East Asian Studies and Near Eastern Studies)

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 the Master of Science and Doctor of Philosophy degrees with a major in pharmaceutical sciences. Concentrations within the major include pharmaceutical chemistry, biopharmaceutics, pharmacokinetics, pharmacodynamics, and pharmacognosy.

A bachelor's degree in pharmacy, chemistry, or biological science is prerequisite to admission to the graduate program. Admission to the doctoral programs usually requires, in addition, appropriate preparation in mathematics.

Teaching is part of the graduate learning process; one or more years of teaching is generally required of graduate students. A thesis based upon laboratory research is required for the master's degree. Acceptable minor fields for doctoral students include biology, chemistry, mathematics, microbiology, nutrition, pharmacology, physiology, zoology, or pharmacy concentrations different from the principal concentration selected by the student.

Specialized facilities of the College of Pharmacy available for graduate study include a clinical pharmacokinetics laboratory, a mass spectrometry laboratory, a nuclear magnetic resonance laboratory, large-scale natural product extraction equipment, computer graphics facilities, animal facilities, and well-equipped laboratories for chemical synthesis, structure elucidation, and pharmaceutical research.

508a-508b. Pharmacokinetics Discussion (1-1) I II Discussion related to the application of pharmacokinetic principles with case-study examples. CR, 507 for 508a, 465 for 508b. (Identical with Ph.Pr. 508a-508b)

512. Quantitative Structure-Activity Relationships (3) 1991-92 Approaches to the quantification of pharmacological actions of drugs on the basis of chemical structure.

527. Antineoplastic Drugs (2) II Discovery and development of natural and synthetic antineoplastic drugs; preclinical screening and toxicity evaluation; phase I, II, and III clinical studies in humans. P, 437b or CR.

537a-537b. Medicinal Chemistry and Pharmacognosy (4-4) Relationships between the chemical structure and physiological activity, incompatibilities and stability of the organic and inorganic compounds obtained from natural and synthetic sources; essentials of pharmacognosy, including biologicals. P, 307, Chem. 241b, 243b.

*May be convened with 400-level course.

596. Seminar
a. Pharmaceutical Chemistry (1) [Rpt./5] I b. Pharmaceutical Chemistry Research (1) [Rpt./5] II c. Pharmaceutics Research (1 to 2) [Rpt./5] I II Open to majors only.

d. Pharmaceutics (1) [Rpt./5 units] II

601. Advanced Physical Pharmacy (3) 1992-93 Applications of physical chemistry to pharmacy. P, physical pharmacy or physical chemistry course.


630a-630b. Advanced Organic Medicinals (3-3) 1992-93 Rational drug design, receptor site theories, mechanism of drug action, and metabolic pathways of medicinal agents; chemical and enzymatic synthesis of important pharmaceuticals. P, 437b, Pcol. 471b.


815. Pharmacy Subspecialty
I. Research (3-10) I II S 15-30L, P, or CR, 10 units of Ph.Pr. 810. (Identical with Ph.Pr. 815I, which is home.)

Pharmacology (PHCL)
College of Medicine, Room 5103 (602) 626-6400

(Pharmacology, College of Medicine)

Professors John D. Palmer, Acting Head (Assistant Professor, Internal Medicine), David S. Alberts (Internal Medicine), H. Vasken Aposhian (Molecular and Cellular Biology), Klaus Brendel, Rubin Bressler (Internal Medicine), Burmell R. Brown, Jr. (Anesthesiology), Ryan J. Huxtable, David G. Johnson (Internal Medicine), Eugene Morkin (Internal Medicine, Physiology), Charles W. Putnam (Surgery), William R. Roseske (Internal Medicine), I. Glenn Sipes (Anesthesiology, Pharmacology and Toxicology), Henry I. Yamamura (Biochemistry; Associate Professor, Psychiatry)

Associate Professors Dean E. Carter (Pharmacology and Toxicology), Thomas P. Davis, Laurel A. Fisher, Edward French, A. Jay Gandolfi (Anesthesiology), Marilyn J. Halonen, David L. Kreulien, Thomas J. Lindel (Molecular and Cellular Biology), Frank Poreca

Assistant Professors Timothy C. Fagan (Internal Medicine), Josephine Lai, Douglas F. Larson, Ronald Lynch

The Department of Pharmacology in the College of Medicine cooperates with the Department of Pharmacology and Toxicology in the College of Pharmacy, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science degree with a major in pharmacology and the Doctor of Philosophy degree in a major in pharmacology and toxicology. See the entry for the Committee on Pharmacology and Toxicology for details on admission and degree requirements.

Pharmacology is a broad discipline involving the investigation of the actions of chemicals upon living material at all levels of organization. It occupies an important interface between the basic medical sciences and the clinical sciences, drawing strongly upon the former for its contribution to the latter. Research in pharmacology utilizes all appropriate techniques of modern biology from the molecular to the cellular levels. Pharmacologic knowledge is applied to the understanding of the basic mechanisms of drug action, the diagnosis, prevention, cure, or relief of the symptoms of disease and the promotion of optimal health. The emphasis on basic pharmacologic principles enables the student to develop techniques of problem-solving to keep abreast of advances in pharmacology and its applications to other sciences.

501. The Pharmacological Basis of Therapeutics (6) II Actions of chemical agents upon living material at all levels of organization, with emphasis on mechanisms of action of prototype drugs; foundation for a rational approach to human therapeutics and toxicology. P, Psio. 691, Bioc. 501. (Identical with Tox. 501)

520. Clinical Pharmacology (2) I Effects of drugs on natural history of disease; drug-drug interactions; drug testing designs; drug abuse; drug literature evaluation; aspects of clinical toxicology, P, 501.

550. Drug Disposition and Metabolism (2) II Principles of absorption, distribution and excretion of drugs, with emphasis on mechanisms of drug metabolism and pharmacokinetics. P, 501; Bioc. 501, tox. 602a. (Identical with Tox. 550)


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

582. Immunotoxicology (2) I (Identical with Tox. 582)

586a-586b. Introduction to Pharmacology and Toxicology Research (1-1) I Introduction to basic research techniques in pharmacology and toxicology through supervised laboratory rotations; student-initiated and faculty-structured lab. exercises in modern pharmacological and toxicological techniques. P, CR, 501, Bioc. 565, Psio. 601.

595. Colloquium
* Introduction to the Neurosciences I (2) 1991-92 P, Consult department before enrolling. (Identical with Med. 595y, which is home)

*z Introduction to the Neurosciences II (2) 1991-92 P, 595y or consult department before enrolling. (Identical with Med. 595z, which is home)

*May be convened with 400-level course.

596. Seminar
a. Advanced Graduate Research (1 to 3) [Rpt./3] I II P, Psio. 596a

601. Analytical Instrumentation and Techniques (4) I (Identical with Tox. 601)

602a-602b. Biotoxicology (3-1) (Identical with Tox. 602a-602b)

605a-605b. Human Neuroscience (3-3) (Identical with Anat. 605a-605b)

620. Principles of Pharmacology (3) I Basic principles of the actions of drugs and of intercellular communication; drug-receptor theory; principles of laboratory investigation in pharmacology and toxicology; historical and philosophical foundations of pharmacology and toxicology. (Identical with Psio. 620 and Tox. 620)

653. Neuropharmacology (3-4) II (Identical with Psio. 653)
Agents that can affect health status in occupation, and control of chemical and physical environments to chemicals. Hazards resulting from occupational and/or environmental exposure to chemicals. A Ph.D. degree in this discipline is awarded through the Graduate Committee on Pharmacology and Toxicology.

Pharmacology (PCOL)
The Department of Pharmacology in the College of Medicine offers programs leading to the Master of Science degree with a major in pharmacology and toxicology. See the entry under Committee on Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements. In conjunction with other departments in the University, the Department of Pharmacology and Toxicology in the College of Pharmacy participates in an interdisciplinary graduate program leading to the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry under Committee on Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements.

Toxicology (TOX)
The Department of Pharmacology and Toxicology in the College of Pharmacy offers a curriculum leading to the Master of Science degree with a major in Toxicology. Prerequisite to admission is the completion of a bachelor's degree including one year each of analytical chemistry, biological science, and organic chemistry and a semester of instrumental analysis. Two letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Required courses for the graduate program are Bioc 562a-562b, Psio 580-581, Phcl 501 (or Pcol 571a-571b), Pcol 574 (or V.Sc. 523R), 565, 601, 602a-602b, 696a. Electives are available to complement the various areas of toxicology. A thesis is required.

Industrial Hygiene Concentration: Admission requirements for the industrial hygiene concentration are identical to those for the Master of Science degree in Toxicology. Required courses for the industrial hygiene concentration are 565, 580, 554, 581, 586, 597, 596a, and F.C.M. 596. A summer internship is recommended, and a thesis is required.

For information on the Doctor of Philosophy degree with a major in pharmacology and toxicology, see the entry under Committee on Pharmacology and Toxicology elsewhere in this catalog.

501. The Pharmacological Basis of Therapeutics (6) II (Identical with Phcl 501)
502. Industrial Hygiene Instrumentation and Analysis (2-4) I (Identical with O.S.H. 502)
508. Insecticide Toxicology (3) II 1991-92 (Identical with Ento 508)
510. Physical Exposures (3) II (Identical with O.S.H. 510)
512. Hazardous Materials (2-4) I (Identical with O.S.H. 512)
523R. General Pathology (3) I 1992-93 (Identical with V.Sc. 523R)
523L. General Pathology Laboratory (1) II 1992-93 (Identical with V.Sc. 523L)
550. Drug Disposition and Metabolism (2) II (Identical with Phcl 550)
554. Industrial Toxicology and Chemical Exposures (2-4) I Principles of toxicology related to industry; dose response; mechanisms of toxicity; 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)
565. Statistics for the Medical Sciences (4) I (Identical with Stat. 565)
566. Physiology Laboratory (2) II (Identical with Ecol 566)
571a-571b. Fundamentals of Pharmacology (4-4) (Identical with Pcol 571a-571b)
574. Clinical Toxicology (2) (Identical with Pcol 574)
576. Environmental Toxicology (3) I Toxicity of natural toxins and of agricultural and industrial
trial chemicals, with emphasis on air and water pollutants; decision-making in environmental issues. P. 6 units of biology and of organic chemistry; Chem. 325, 326. (Identical with Ento. 576 and Phcl. 576)

580. * Human Physiology (4) II (identical with Ps. 580)

581. Industrial Ventilation (3) II Design and evaluation of industrial ventilation systems. Emphasis is on level evaluation of industrial contaminants. Five laboratory exercises and course design project. 3R, 1L

582. Immunotoxicology (2) I Broad overview of the immune system, with emphasis on how chemicals affect the immune system (immunomodulation) and the role of the immune system in chemical-induced tissue injury/allergic responses. P. 602, Micr. 419R, 567. (Identical with Micr. 582 and Phcl. 582)

586. * Fundamentals of Industrial Hygiene (3) I (Identical with O.S.H. 586)

587. * Advanced Industrial Hygiene and Safety (3) II (Identical with O.S.H. 587)

596. Seminar
   a. Advanced Toxicology (1-2) [Rpt. /3] I
   b. Current Concepts in Toxicology (1-2) [Rpt. /3] II

601. Analytical Instrumentation and Techniques (2-4) I Lecture and laboratory in the qualitative and quantitative determination of toxic substances in the environment and body fluids. Modern instrumental techniques will be employed whenever appropriate. Lecture may be taken separately by non-majors. 2R, 6L. P. Chem. 325, 326. (Identical with Phcl. 601)

602a-602b. Biotoxicology (3-4) 602a: I Lecture. Mechanisms of organ directed toxicities in animals. Chemical carcinogenesis, teratogenesis, and mutagenesis. Open to non-majors. P. two semesters of ecology. 602b: II Laboratory. Proper use of animals in toxicology and pharmacology research; focuses on organ specific toxicities. (Identical with Phcl. 602a-602b)

610. Topics in Advanced Toxicology (1-3) II Current developments in toxicology including: chemical carcinogenesis, mutagenesis and teratogenesis; behavioral toxicology; inhalation toxicology; toxicokinetics; metabolism and environmental toxicology. P. 601, 602a-602b.

620. Principles of Pharmacology (3) I (Identical with Phcl. 620)

653. Neuropsychopharmacology (3-4) II (Identical with Psol. 653)

696. Seminar
   a. Student Research (1) II (Identical with Phcl. 696a, which is home)

Pharmacology and Toxicology

College of Medicine, Room 5103 (602) 626-7912

Committee on Pharmacology and Toxicology (Graduate)

Professors David S. Alberts (Cancer Center), H. Vasken Aposhian (Molecular and Cellular Biology), G. Tim Bowden (Radiation Oncology), Klaus Brendel (Pharmacology), Ruben Bressler (Internal Medicine), Burnell R. Brown (Anesthesiology), Dean E. Carter (Pharmacology and Toxicology), Paul F. Consore (Pharmacology and Toxicology), A. Jay Candolfi (Anesthesiology), Ryan J. Huxtable (Pharmacology), Wayburn S. Jeter (Emelitus, Pharmacology and Toxicology), David G. Johnson (Internal Medicine), Eugene Morkin (Heart Center), John D. Palmer (Pharmacology), Charles W. Putnam (Surgery), William R. Roeseke (Internal Medicine), Findlay E. Russell (Pharmacology and Toxicology), I. Glenn Sipes (Pharmacology and Toxicology), Henry I. Yamamura (Pharmacology)

Associate Professors David L. Kreulen, Chair, William S. Dalton (Internal Medicine), Thomas P. Davis (Pharmacology), Timothy C. Fagan (Internal Medicine), Laurel Fisher (Pharmacology), Edward D. French (Pharmacology), James R. Halpert (Pharmacology and Toxicology), Hugh E. Laird II (Pharmacology and Toxicology), Charlene A. McCauley (Pharmacology and Toxicology), Frank Pesceca (Pharmacy), John B. Sullivan (Pharmacy)

Assistant Professors Josephine Y. Lai (Pharmacology), Douglas F. Larson (Pharmacology; Associate Professor, Surgery), Ronald Lynch (Pharmacology), Daniel C. Liebler (Pharmacology and Toxicology), John W. Regan (Pharmacology and Toxicology), Sandra R. Rossie (Pharmacology and Toxicology)

The Department of Pharmacology in the College of Medicine and the Department of Pharmacology and Toxicology in the College of Pharmacy cooperate, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science with a major in pharmacology and the Doctor of Philosophy with a major in pharmacology and toxicology. Concentrations are available in neuro- and psychopharmacology; in biochemical, molecular, behavioral, cardiovascular, endocrine, gastrointestinal, and autonomic pharmacology; and in biochemical, occupational, inhalation, and environmental toxicology.

Admission requires the completion of a bachelor's degree with a major in chemistry, biology, pharmacy, or other related science. Minimal prerequisites include one year each of biology, organic chemistry, and physics and course work in mathematics through integral calculus. Applicants must submit scores on the Graduate Record Examination. Correspondence may be directed to the Chairperson of the Graduate Committee on Pharmacology and Toxicology.

Graduate study programs are individually planned after consideration of the student's preparation and professional objectives. A thesis is required. For course descriptions, see Pharmacology (College of Medicine) and Pharmacology and Toxicology (College of Pharmacy) elsewhere in this catalog.

Pharmacy Practice (PHPR)

Pharmacy Building, Room 318 (602) 626-5730

Professors J. Lyle Bootman, Head, Theodore G. Tong

Associate Professor Patricia M. Plezia

The Department of Pharmacy Practice offers a program leading to the Master of Science degree with a major in pharmacy with concentrations in institutional pharmacy administration and pharmacy administration. Graduate study in pharmacy administration leading to the Doctor of Philosophy degree with a major in pharmacy is offered in this department.

A bachelor's degree in pharmacy or a Doctor of Pharmacy degree is prerequisite to admission to the institutional pharmacy administration concentration. Admission preference for graduate study in pharmacy administration is given to applicants who hold the degree of Bachelor of Science in Pharmacy or its equivalent. Applicants with bachelor's degrees in a field other than pharmacy will also be considered.

Teaching is a part of the graduate learning process, and one year of teaching or more is generally required of all graduate students. A thesis is required for the master's degree. Acceptable minor fields for doctoral students include anthropology, biostatistics, computer science, economics, educational psychology, management, marketing, management information systems, psychology, public administration, or sociology.

507. * Pharmacokinetics (4) I (Identical with Ph.Sc. 507)

508a-508b. * Pharmacokinetics Discussion (1-1) II (Identical with Ph.Sc. 508a-508b)

511. Pharmacy Management (3) I History, organization and administration of pharmaceutical services within the institutional environment.

512. Advanced Pharmacy Management (3) II Application of management principles to problem-solving and decision-making techniques in the provision of pharmaceutical services within the institutional environment. Field trips. Open to majors only. P. 511.

547. Perspectives in Geriatrics Laboratory (1) I IP, CR. 448. (Identical with Gero. 547 and N.F.S. 547)

548. Perspectives in Geriatrics (2) II Multidisciplinary approach to the health-care needs of the elderly, including medication use, nutrition, health care agencies and roles of individual health care professionals. Open to non-majors. P. CR, 447 for nonmajors. (Identical with Gero. 548)

583. * Perspectives of Cancer Care for Health Professionals (3) S (Identical with Nurs. 583)

589. * Clinical Pharmacotherapy of Mental Disorders (2) I II A multidisciplinary approach to clinical psychopharmacology, therapeutics, and diagnosis of mental disorders for health professionals.

*May be convened with 400-level course.
Philosophy (PHIL)

Social Sciences Building, Room 213
(602) 621-3129


Associate Professor J. Christopher Maloney, Joseph T. Tollever
Assistant Professors Thomas Christiana, David Owen

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in philosophy. In addition to the traditional areas of philosophy, concentrations are available that bridge philosophy with other disciplines such as law or cognitive science.

Applicants for the graduate program should normally have completed 30 units of undergraduate work in philosophy. In addition to application materials required by the Graduate College, applicants should submit to the department a copy of their completed application, copies of transcripts (these need not be official), three letters of recommendation from philosophy instructors, GRE general aptitude scores, and a sample of their written philosophy work.

Degrees

Master of Arts: A student must demonstrate proficiency in logic, and in addition must pass at least one course in each of the following three areas: history of philosophy, metaphysics and epistemology, and moral philosophy. A final examination must be passed, based on a research paper in an area chosen by the student. The student's program of study is designed individually. No thesis is required.

Doctor of Philosophy: A student must pass two courses in each of the following four distribution areas: (1) logic (required), philosophy of language, and philosophy of science; (2) history of philosophy; (3) epistemology and metaphysics; and (4) moral, social, and legal philosophy. A substantial proportion of one's coursework must be in areas of the student's choice, and a doctoral dissertation is required. Further details about requirements and procedures can be obtained from the department. Teaching assistantships are available for qualified students.

503.* Foundations of Mathematics (3) II 1992-93 (Identical with Math. 503)
512.* Readings in Greek Philosophy (3) [Rpt.] (Identical with Grk. 512)
514.* Philosophical Logic (3) Introduction to modal logic; problems of interpretation and application; extensions to such areas as tense logic, epistemic logic, deontic logic.
515. Advanced Topics 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.
517.* 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) Laws and models in biology, structure of evolutionary theory, teleological explanations, reductionism, sociobiology. (Identical with Ecol. 521)
522.* Linguistic Semantics and Lexicology (3) II 1992-93 (Identical with Ling. 522)
523.* Philosophy of the Physical Sciences (3) Philosophical problems regarding space, time, motion, relativity, causality, measurement, theoretical entities.
524.* Philosophy of Social Sciences (3) Theories, concepts, and forms of understanding in the social sciences. Possible topics: rational choice and decision at the individual and social levels; democracy; and market mechanisms. One course in philosophy.
530a-530b.* Ethical Theory (3-3) 530a: Metaethics—meaning of moral terms, relativism, subjectivism, ethics and science, social contract theory. 530b: Normative ethics—Utilitarianism, egoism, rights, natural law, justice, deontological duties, blameworthiness and excuses.
533.* Aesthetics (3) Classical and contemporary theories of art; the aesthetic experience, form and content, meaning, problems in interpretation and criticism of works of art.
534.* Social and Political Philosophy (3) Fundamental concepts of politics; leading social and political theories, such as anarchism, social contract, Marxism.
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. * Ethics and the 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.


545. * Philosophy of Mind (3) Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, emotion, memory and action.

546. * Philosophy of Psychology (3) Examination of philosophical issues arising from current work in psychology including perception, reasoning, memory, motivation and action.

548. * Philosophy of Language (3) Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical form.

550. * Philosophy of Mind (3) Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, emotion, memory and action.

551. * Philosophy of Psychology (3) Investigation of philosophical issues arising from current work in psychology including perception, reasoning, memory, motivation and action.

552. * Philosophy of Language (3) Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical form.

554. * Philosophy and Artificial Intelligence (3) Interdisciplinary problems lying at the interface of philosophy and artificial intelligence.

556. * Formal Semantics (3) I Introduction to model-theoretic investigations of natural language interpretation, including coordination, quantification, referential relations, tense, aspect, and modality. (Identical with Ling. 564)

557. * Pragmatics (3) 1991-92 (Identical with Ling. 565)


560. * Philosophy of Mind (3) Topics include the nature of mental states; the relation between mind and brain; and analysis of perception, emotion, memory and action.

561. * Philosophy of Psychology (3) Investigation of philosophical issues arising from current work in psychology including perception, reasoning, memory, motivation and action.

562. * Philosophy of Language (3) Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical form.

f. Social and Political Philosophy (3) [Rpt./2]

6. Philosophy of Law (3) [Rpt./2]

9. Philosophy of Mind (3) [Rpt./2]

l. Philosophy of Language (3) [Rpt./2]

p. History of Philosophy: Ancient (3) [Rpt./2]

q. History of Philosophy: Recent (3) [Rpt./2]

r. Philosophical Psychology (3) [Rpt./2]

s. Philosophy of Mathematics (3) [Rpt./2]

t. Special Problems (3) [Rpt./2]

v. Philosophy and Cognitive Science (3) [Rpt./2]

### Physical Education

(See Exercise and Sport Sciences under Health-Related Professions)

### Physics (PHYS)

PAS Building, Room 260
(602) 621-6824


Associate Professors Adam S. Burrows, Anna Hasenfratz, Ke-Chiand Hsieh, Sumit Mazumdar, Michael A. Shupe, Dan Stein, Douglas Toussaint, Jay E. Treat (Emeritus)

Assistant Professors Geoffrey A. Forden, Kenneth A. Johns, Ina Sarcevic, Wing Y. Tam

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in physics. Some interdisciplinary programs such as chemical physics, optics, and astrophysics are also available. Further information regarding these programs may be obtained from the department. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in physics. For information concerning this degree see Requirements for Master's Degrees/ Master of Education elsewhere in this catalog.

Prerequisites for admission to full graduate standing are thirty semester units of undergraduate work in physics. These will normally include the following work beyond introductory physics: appropriate laboratory work; one semester each of mechanics, thermodynamics, and optics; two semesters of electricity and magnetism; and two semesters of modern physics including quantum mechanics. All applicants must submit scores on the aptitude and advanced tests of the Graduate Record Examination.

An advisor is assigned to each graduate student to help plan a program for the advanced degree. Students without deficiencies are required to take, during the first week of classes, a qualifying comprehensive examination. This diagnostic examination covers undergraduate physics only; and the results will be used to help in determining an appropriate course of studies. Two attempts to pass this examination are permitted. Experience in teaching is an essential part of graduate training in physics. Graduate students are required to teach an amount determined on an individual basis by the graduate adviser and the department as a whole. Graduate students are required to take 695 until the preliminary examination is passed.

### Degrees

**Master of Science:** At least fifteen of the required thirty units of graduate work must be in physics and must include 536, 515a or 515b or the equivalent. Also, each student must satisfy one of the following options: (1) write a thesis (for which up to six units may be allowed) and pass an oral examination on the thesis; (2) take 21 of the 30 required graduate units in physics and pass a comprehensive final oral examination; (3) pass the written and oral parts of the preliminary examination for the Doctor of Philosophy degree.

**Doctor of Philosophy:** Each student must complete at least 36 units of graduate work in physics exclusive of the dissertation and the supporting (minor) work. Courses will be chosen in consultation with the graduate adviser. Each student must complete three of the following courses: 535, 551, 561, 581, 583a, and 685. The preliminary examination will cover classical mechanics, electromagnetic theory, relativity, statistical mechanics, experimental physics, quantum mechanics, modern physics, and questions on current developments. The courses 511, 515a-515b, 528, and 570a-570b indicate the areas covered in the examination and the level of understanding expected of the student. The preliminary examination must be taken, at the latest, during the fifth semester (excluding summer sessions) of residence. It is expected that the dissertation, based upon original research, will be published in a refereed journal. The minor work may be satisfied within the Department of Physics and, in this case, some courses taken in other departments may be used as well. An additional twelve units of work, chosen in consultation with the graduate adviser, are required for the minor in physics.

Proficiency in one foreign language is required. Information on methods of demonstrating proficiency may be obtained from the Department of Physics.

Students intending to minor in physics (to supplement a major in another department) should consult the physics minor adviser early in their graduate work.

Experimental research is conducted in the following areas: elementary particle physics, cosmic rays and space physics, solid state...
Advanced physics, atomic and molecular physics, nuclear physics, carbon dating, surface science, quantum optics, biophysics, and general relativity. Theoretical research is conducted in: solid state physics, atomic physics, nuclear physics, elementary particles, field theory, general relativity, cosmology, astrophysics and non-equilibrium statistical mechanics. Prospective students should write to the department for information about specific research programs, the faculty involved, the facilities available, and the research and teaching assistantships or fellowship support which can be offered. It is the policy of the department to award financial aid in the form of teaching assistantships solely on the basis of the student's academic record and financial needs. Fellowships are also available to first-year graduate students.

502.* Medical Physics (3) I Basic physics of the human body: the principles of mechanics, electricity, sound, light, and radiation as they apply to physiology, with emphasis on instrumentation for diagnosis and treatment. P. 102b.

504. Introduction to Quantum Optics (3) II (Identical with Opti. 504)

511. Analytical Mechanics (3) I Laws of motion as developed by Newton, d'Alembert, Lagrange and Hamilton; dynamics of particles and rigid bodies. P. 410.

513. Topics in Advanced Mechanics (3) II Modern topics in classical mechanics, including canonical perturbation theory, invariant mappings, nonintegrated system stochastic behavior and applications to semi-classical quantum theory. P. 511.


525. Advanced Thermodynamics and Kinetic Theory (3) I 1991-92 First and second laws of thermodynamics and their applications; Boltzmann transport equation; H-theorem; mean free path; methods applied to viscosity, thermal conductivity, and diffusion. P. 425.

528. Statistical Mechanics (3) II Physical statistics; the connection between the thermodynamic properties of a macroscopic system and the statistics of the fundamental components; Maxwell-Boltzmann, Fermi-Dirac, Einstein-Boose statistics. P. 475b.

530.* Introduction to Biophysics (2) I Concepts and experimental techniques of molecular biophysics; physical properties of biological molecules and cell organelles, optical interactions, macromolecular transitions, molecular mechanism or regulation. P. 102b, Chem. 103a-103b. (Identical with Micr. 530)

531. Biophysical Theory (2) II Physical concepts and theories describing biomolecular structure and function, molecular evolution, limits to structure, symmetry, oligomer and virus structure, protein, and membrane structure and function. (Identical with Micr. 531)

533.* Physics Demonstrations (1-3) II Introduction to teaching materials and laboratory demonstrations illustrating principles of classical and modern physics, with emphasis on inexpensive techniques and direct experience.

Advanced degree credit available for nonmajors only. P. two semesters of physics.

535. Advanced Atomic Physics (3) II 1992-93 Details of atomic structure; interactions of atoms with electromagnetic fields, electrons and ions; techniques for calculating unperturbed energy levels, transition probabilities, and atomic interaction cross sections. P. 511, 515b, 570b.

536.* Applications of Introductory Quantum Theory (3) II Applications of quantum theory to molecules, atomic nuclei, elementary particles and simple solids. P. 435.

540a-540b.* Atomic and Molecular Spectroscopy for Experimentalists (3-3) Experimental techniques to generate, analyze and detect photons from X-ray to IR; interpretation of spectra from gases, liquids, solids and biological macromolecules; light scattering, polarization. P. 330 or 112b. (Identical with Opti. 540a-540b)

543. Laser Physics (3) I (Identical with Opti. 543)

545. Experimental Physics 545a-545b-545c are three five-week lecture courses; none is prerequisite to any other.

a.* Experimental Spectroscopy (1) I II S Laboratory experiments with spectroscopic sources, spectrometers, instrument functions, detectors, light collection optics, spectral recording and analysis. P. 110, 116, 121, or consult department before enrolling.

b.* Experimental Acoustics (1) I II S Laboratory experiments with sound sources, oscilloscopes, spectrum analyzers, sound level meters, filters, musical instruments, recording, room acoustics. P. 110, 116, 121, or consult department before enrolling.

c.* Experimental Microscopy, Light Scattering and Optics of Small Particles (1) I II S Laboratory experiments with microscopes and polarized scattered light to characterize small particles and surfaces, optical constants, lasers remote sensing. P. 110, 116, 121, or consult department before enrolling.

550.* Introductory Nuclear Physics (3) I Basic concepts of nuclear physics: structure and stability of nuclei; nuclear forces; stable systems; nuclear reactions; decay of unstable systems; nuclear radiation characteristics. P. 330 or 112b, Math. 254.

551. Nuclear Physics (3) I Theory of nuclear systems, including stability, decay, nuclear forces, scattering, reactions, structure, and interaction with electromagnetic radiation. P. CR, 570a-570b.


555a-555b. Electrodynamics of Conducting Fluids and Plasmas (3-3) 1992-93 (Identical with Pty.S. 555a-555b)


560.* Introductory Solid-State Physics (3) I II Properties of solids from molecular, atomic, and electronic theory; electric, magnetic, and thermal properties of metals, insulators, and semiconductors; free electron and band theories. P. 330 or 112b.


570a-570b. Quantum Mechanics (3-3) Principles of quantum mechanics; wave mechanics and matrix mechanics; applications to atomic structure and spectroscopy. P. 475a-475b recommended but not required.

571. Symmetry Groups in Physics (3) I Algebraic results of the theory of groups which find repeated applications in atomic, molecular, nuclear and particle physics. Continuous groups, Lie algebras, discrete groups, irreducible tensors. P. 570a-570b.

575a-575b.* Methods of Mathematical Physics (3-3) Vector and tensor analysis; differential and integral equations; Green's functions; variational techniques; linear operator theory, with emphasis on physical applications. P. 410, Math. 254, CR, 415a-415b.

*May be conved with 400-level course.

577a-577b. Theory of Relativity (3-3) 1992-93 Special theory of relativity and its application to mechanics and electrodynamics; tensor calculus and general relativity; relativistic astrophysics and cosmology. P. 475b.

579a-579b. Advanced Relativistic Quantum Mechanics (3-3) Continuous groups; scattering theory; relativistic wave equations; quantum electrodynamics, Feynman diagrams, dispersion theory, renormalization; strong and weak interactions. P. 515b, 570b.

580a-580b. Quantum Field Theory (3-3) 1991-92 Meaning of quantized fields; symmetry principles, free fields; general properties of interactions and peculiarities of electrodynamics and gravity. P. 570b, 577a.

581. Elementary Particle Physics (3) I Production, interaction, and decay of mesons, baryons and leptons; high energy scattering of elementary particles; particle classification and symmetries; theoretical interpretation. P. 436.


585. Stellar Pulsation (1-3) I (Rpt.) I II Stellar pulsation, the solar atmosphere, solar seismology and long-term solar variability related to climate.

586. Techniques in Particle Physics (3) I II 1992-93 Classification of elementary particles and their interactions with matter, relativistic kinematics, detectors, data acquisition techniques, statistical techniques, analysis of experiments, cosmic radiation, and accelerators.

588. Topics in Theoretical Astrophysics (3) I (Rpt.) I Current topics in theoretical astrophysics in depth, with emphasis on the methodology and techniques of the theorist and the cross-disciplinary nature of astrophysics theory.
Example subjects are nuclear astrophysics, hydrodynamics, transient phenomena, planetary interiors and atmospheres, neutron stars, jets, and the evolution of star clusters. (Identical with Astr. 589 and Pty. S. 589)

596. Seminar
a. Current Problems in Molecular Biophysics (1) I, II (Rpt.) (Identical with Micr. 596a)
   c. The Physics of Thin Films (3) II P, 460.

643. Quantum Optics (3) II 1992-93 (Identical with Opt. 643)

685. Graduate Physics Laboratory (3) [Rpt./2] II Introduction to modern research methods and experiments. Problems in low-temperature physics; solid-state, atomic, and nuclear spectroscopy; computer-based data acquisition and analysis; solar-energy physics; and others.

695. Colloquium
a. Current Problems in Physics (1) [Rpt.] I II

697. Workshop
a. Problems in Computational Science (6) I II (Identical with Math. 697a, which is home) [Note: This is a two semester course in which students receive a "K" grade at the end of the first semester.]

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**Physiological Sciences**

Arizona Health Sciences Center
Room 4126A
(602) 626-2016

Committee on Physiological Sciences (Graduate)

Professors William H. Dantzler, Chair (Physiology), Ronald E. Allen (Animal Sciences), Eldon J. Braun (Physiology), Darrel E. Goll (Animal Sciences, Biochemistry), Robert W. Gore (Physiology), Joseph F. Gross (Chemical Engineering), Raphael P. Gruener (Physiology), William H. Dantzler, Chair (Physiology), Paul C. Johnson (Physiology), Eugene Morkin (Internal Medicine), Otakar M. Katz (Internal Medicine), Otakar Koldovsky (Pediatrics), Richard J. Lemen (Pediatrics), Timothy G. Lohan (Exercise and Sport Sciences), Robert S. McCuskey (Anatomy), Eugene Morkin (Internal Medicine), William R. Roeske (Internal Medicine), Douglas G. Staurt (Physiology), Charles M. Tipton (Exercise and Sport Sciences), Marc E. Tischler (Biochemistry)

Associate Professors Janis M. Burt (Physiology), Roger M. Enoka (Exercise and Sport Sciences), Laureal A. Fisher (Pharmacology), Robert J. Gillies (Biochemistry), Ziaul Hasan (Physiology), Patricia B. Hoyer (Physiology), David L. Kreulen (Pharmacology), Richard B. Levine (Division of Neurobiology, Arizona Research Laboratories), Charles M. Tipton (Exercise and Sport Sciences), Marc E. Tischler (Biochemistry)

Assistant Professors Edmund A. Arbas (Division of Neurobiology, Arizona Research Laboratories), Ralph F. Fregosi (Exercise and Sport Sciences), Barry S. Komm (Biochemistry), Kevin C. Kregel (Exercise and Sport Sciences)

The interdisciplinary committee on Physiological Sciences offers graduate work leading to the Doctor of Philosophy degree with a major in physiological sciences. The Master of Science degree is offered only in rare instances when individuals qualify to study for the Ph.D. They are forced to terminate their graduate education. Research training is an integral part of the Ph.D. program. The research areas of the faculty in the program include: cellular and transport phenomena; circulation and respiration, including microcirculation; comparative physiology; endocrinology; exercise physiology; gastrointestinal physiology; muscle physiology; neural mechanisms, including motor control and neuroendocrinology; renal mechanisms; and reproductive and developmental mechanisms.

Applicants for the Ph.D. program in physiological sciences should hold a bachelor's degree in the physical or biological sciences, engineering, mathematics or other suitable 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, as is familiarity with microcomputers and a programming language. An introductory course in the biological or zoology is advisable for physical science majors. The Graduate Record Examination and three letters of recommendation are required to assist in evaluation of applicants.

In the first year, students in the program take a core sequence of courses including Cell Physiology, Psio. 503; and Systems Physiology, Psio. 601 (or Psio. 580 by special petition to the program committee). Programs of study are determined in conjunction with the student's major advisors and the Graduate Program Committee. Considerable flexibility is possible so that the needs of each student can be best served. A wide variety of courses is available, including electives offered by the departments of Animal Sciences, Biochemistry, Ecology and Evolutionary Biology, Exercise and Sport Sciences, Nutrition and Food Science, Physiology, and Veterinary Science. Details of these courses may be found in listings of the relevant departments in this catalog.

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**Physiology (PSIO)**

Arizona Health Sciences Center
Room 4103
(602) 626-7642

(College of Medicine)

Professors Douglas G. Staurt, Head, Eldon J. Braun, William H. Dantzler, Robert W. Gore, Joseph F. Gross (Chemical Engineering), Raphael P. Gruener, Paul C. Johnson, Murray Katz (Internal Medicine), Otakar Koldovsky (Pediatrics), Eugene Morkin (Internal Medicine), Marc E. Tischler (Biochemistry)

Associate Professors Janis M. Burt, Roger M. Enoka (Exercise and Sport Sciences), Andreas M. Goldner, Ziaul Hasan, Patricia B. Hoyer, David Kreulen (Pharmacology), Richard B. Levine (Division of Neurobiology, Arizona Research Laboratories), Ziaul Hasan, Joseph F. Gross (Chemical Engineering), Raphael P. Gruener, Paul C. Johnson, Murray Katz (Internal Medicine), Otakar Koldovsky (Pediatrics), Eugene Morkin (Internal Medicine), Marc E. Tischler (Biochemistry)

The Department of Physiology teaches and does scholarly work on physiological mechanisms of significance to medicine. In both teaching and research, the orientation of the department is broad, encompassing single cell, organ, and total body function.

The Department of Physiology participates in offering a program of instruction leading to the Doctor of Philosophy degree with a major in physiological sciences through the Committee on Physiological Sciences. For admission and degree requirements, please see Physiological Sciences and Requirements for Doctor's Degrees elsewhere in this catalog. A Master of Science degree is offered only in rare instances when individuals qualify to study for the Ph.D. They are forced to terminate their graduate education.

Current research areas of the faculty in the Department of Physiology include: cellular and transport phenomena; circulation and respiration, including microcirculation; comparative physiology; endocrinology; gastrointestinal physiology; mathematical physiology; muscle physiology, neural mechanisms, including motor control; regulation of bone formation; renal mechanisms; and reproductive and developmental mechanisms.

The specialized nature of the material and equipment required for courses given in the College of Medicine may necessitate some limitation of enrollment. Medical students will receive preference in courses required for the M.D. degree. All other students must obtain the permission of the instructor before enrolling. Graduate students already enrolled in the College of Medicine departments will be given preference.

In addition to the courses listed below, the Department of Physiology offers temporary courses in the following areas, subject to faculty availability and student interest: neurophysiology, renal physiology, physiology of muscle, molecular and cellular endocrinology, peripheral vascular physiology, respiratory physiology, gastrointestinal and developmental physiology, membrane transport processes in physiology, and cardiac physiology.

503. Cellular Physiology (4) I Fundamental responses of living organisms to environmental changes, by examining mechanisms which operate at the cellular level. Topics include organelle structure and function, transmembrane homeostasis and transport phenomena, excitability, intercellular and intracellular communication, cellular mobility, and nervous system function. P, Chem. 103b, 104b, 241b, 243b; Phys. 102b; Math. 125a-125b; Block. 460.
Planetary Sciences (PTYS)
Space Sciences Building, Room 325
(602) 621-6963

Participating Scientists from the Lunar and Planetary Laboratory:
Senior Research Scientists Lyle A. Broadfoot, Larry A. Lebofsky, Donald E. Shemansky Associate Research Scientists Jay B. Holberg, Lon L. Hood, Bill R. Sandel Assistant Research Scientists Robert McMillan, Ann Vickery

The department offers multidisciplinary programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in planetary sciences. Areas of specialization include, but are not restricted to, experimental, observational, and theoretical study of planetary atmospheres; the interiors of the planets and planetary satellites; asteroid and cometary astronomy and physics; meteoritics, problems of plasma physics and cosmic rays; the solar wind and its interaction with solar system bodies; celestial dynamics; investigations of the formation of the solar system and other planetary systems. Students are normally admitted to the doctoral program only. In certain circumstances, however, students may be admitted to the Master of Science degree program as a terminal or intermediate degree.

Applicants should have completed an undergraduate major in a physical science such as astronomy, atmospheric sciences, chemistry, geology, mathematics, or physics. However, admission is based on the overall demonstrated capability and preparation of the applicant. For full consideration, applicants must submit applications, including scores on the aptitude and advanced (chemistry, geology, or physics) tests of the Graduate Record Examination, as well as the names of at least three references. Personal or telephone interviews are desirable in aiding the deliberations of the admissions committee.

The minor: Students are required to complete a minor consisting of at least 12 units, arranged in consultation with the faculty and department head. The majority of courses submitted in compliance with the minor requirement should be at the 500 level or above; no more than 6 units may be taken at the 400 level. The grade average for minor courses must be completed with at least a "B" average.

Degrees

Master of Science: This program is available only in special circumstances, with the concurrence of the faculty. At least 18 units drawn from the graduate core curriculum and a thesis suitable for publication are required.

Doctor of Philosophy: All students must complete the 15-unit core program consisting of 505a-505b-505c, 510, and 554 (though exceptionally well-prepared may have parts of this requirement waived). An additional minimum of 21 units must be completed in a specialized area of planetary sciences. A specified reading competence in a modern foreign language is required. Students are expected to complete all requirements for the degree within three or four years following successful completion of the preliminary examination, which itself should be taken by the end of the second year of graduate enrollment.

The Department of Planetary Sciences' degree programs are conducted in collaboration with the research programs of the Lunar and Planetary Laboratory (LPL). Together, the department and laboratory form an institute uncommonly broad and complete in its approach to planetary science education and research. The department and laboratory participate in many NASA space science missions. Among the current missions in which the faculty are participating are the Voyager Mission, the Magellan Mission to Venus, the Galileo Mission to Jupiter, the Cassini/Huygens Mission to Saturn, the Comet Rendezvous Asteroid Flyby Mission, and the Ulysses Heliospheric Probe. In addition, LPL scientists make use of Earth orbiting observatories, including the Hubble Space Telescope and the Ultraviolet Explorer.
The laboratory's Space Imagery Center contains one of the most extensive collections of planetary images in the world, beginning with those obtained from the earliest space projects and continuing to most current missions. LPL's Planetary Imaging Research Laboratory is a modern image processing facility for the analysis of planetary and astronomical data. Also available for student research are cosmochemistry and geochemistry laboratories, including a scanning electron microscope and microprobe facility, an experimental petrology laboratory, a radiochemistry separation and neutron activation laboratory, and a noble gas mass spectrometry laboratory. The numerous telescopes of the University of Arizona Observatories are available for research projects, including instruments on Kitt Peak and in the Santa Catalina Mountains, as well as the Multiple Mirror Telescope on Mt. Hopkins; all are within easy reach of the University campus. Laboratory staff and students also make use of major observatories around the world, including the NASA Infrared Telescope Facility on Mauna Kea, Institute conduct a regular program of planetary, solar, and stellar infrared spectrometry using the NASA Kuiper Airborne Observatory. The University is developing a new observatory site on Mt. Graham, northeast of Tucson. The department participates in interdepartmental programs in theoretical astrophysics and in applied mathematics.

The University's computer center, including a Convex supercomputer, is available to support educational and research activities. The Lunar and Planetary Laboratory maintains a variety of interconnected computers and workstations in support of the research and educational programs.

503.* Introduction to the Solar System (3) I 1991-92 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. (Identical with Astr. 503 and Geos. 503)


510. Principles of Cosmochemistry (3) I 1992-93 Chemical compositions of solar system objects; equilibrium and nonequilibrium chemical processes applied to planets; cosmochronology. (Identical with Geos. 510)


519.* Global Tectonic Processes (3) II (Identical with Geos. 519)

520. Meteorites (3) II 1992-93 Classification; chemical, mineralogical and isotopic composition; petrology; ablation processes; interaction with solar and cosmic radiation; relation to comets and asteroids. P, S. (Identical with Geos. 520)


530. Chemical Evolution of the Earth (3) I (Identical with Geos. 530)

541a-541b.* Dynamic Meteorology (3-3) (Identical with Atmo. 541a-541b) *May be convened with 400-level course.

544. Physics of High Atmospheres (3) II 1991-92 Physical properties of upper atmospheres, including gaseous composition, temperature and density, ozonosphere, and ionospheres, with emphasis on chemical transformations and eddy transport. (Identical with Atmo. 544)

545. Stellar Atmospheres (3) I 1991-92 (Identical with Astr. 545)


554. Evolution of Planetary Surfaces (3) II 1992-93 The geologic processes and evolution of terrestrial planet and satellite surfaces including the Galilean and Saturnian and Uranian satellites. Course includes one or two field trips to Meteor Crater or other locales. (Identical with Geos. 554)


567. Inverse Problems in Geophysics (3) II 1992-93 (Identical with Geos. 567)

571. Terrestrial Planets (3) I 1991-92 Geophysical and geochemical techniques used to deduce composition and evolution of terrestrial planets. Topics include the Earth, Moon, Mars, Venus, and meteors. (Identical with Geos. 571)

582. High Energy Astrophysics (3) II 1991-92 (Identical with Astr. 582)

583. Thermodynamics in Geosciences (3) I (Identical with Geos. 583)

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

596. Seminar


Planning (PLNG)

Committee on Planning (Graduate)

Professors Fred S. Matter, Co-chair (Architecture), Gordon F. Mulligan, Co-chair (Geography), Robert B. Bechet (Psychology), Michael Bonine (Geography), Nathan Buras (Hydrology and Water Resources), Hanna J. Cortner (Renewable Natural Resources), Kenneth E. Foster (Arid Lands), Lay J. Gibson (Geography), Robert C. Giebner (Architecture), R. Frank Gregor (Renewable Natural Resources), William Haynes (Landscape Architecture), Robert Hershberger (Architecture), Helen M. Ingram (Political Science), David A. King (Renewable Natural Resources), W. Kirby Lockard (Architecture), Lawrence D. Mann (Geography), Philip R. Ogden (Forest Management), Richard W. Reeves (Geography), Sandra Rosenbloom (Architecture), Thomas F. Saarinen (Geography), Arthur L. Siwers (Management and Policy), Sorosh Sorouhi (Hydrology and Water Resources), Ervin H. Zube (Renewable Natural Resources)

Associate Professors D. Robert Altschul (Geography), Harry der Boghoshian (Architecture), Michael D. Bradley (Hydrology and Water Resources), Michael Deeter (Landscape Architecture), Dennis C. Doxtater (Architecture), Charles E. Glass (Mining and Geological Engineering), Alfredo R. Huete (Soil and Water Science), Stuart E. Marsh (Arid Lands Resource Sciences), E. Gregory McPherson (Landscape Architecture), David A. Plane (Geography), Charles M. Foster (Architecture), Donovan C. Wilkin (Renewable Natural Resources), Robert H. Wortman (Civil Engineering)

Assistant Professors Robert M. Itami (Landscape Architecture), D. Phillip Guerin (Watershed Management)

The interdisciplinary Committee on Planning directs a graduate professional program leading to the Master of Science degree with a major in planning. The major consists of 54 units: 36 units of core course work, 9 units in a chosen area of concentration, and 9 units of free electives. Core courses include 500, 544, 557, 584, 602, 605, 609, 611, 657, 693, 696, and Law 660. Areas of concentration include: arid lands (addressing development and air environments), community (planning megaregional command, dimensions of urban design), environmental change (stress the behavioral aspects of environmental issues), regional planning (emphasizing mainstream urban and regional land-use development), renewable natural resources (allowing both resource management and landscape design options), transportation planning (stress travel forecasting and facilities design), and wa-
The program requires completion of a project course and a comprehensive written examination must be taken prior to completion of the 54 units of course work. Internship experience is required and students are exposed to field applications in other course work as well. The program is specifically designed to expose students to the interdisciplinary nature of most planning problems. The course work provides a mixture of theoretical and practical perspectives on diverse planning issues.

Interested persons should contact one of the two committee co-chairs for further information.

500. Ecosystems and Urban Planning (3) I (Identical with H.W.R. 500)
506. Fundamentals of Physical Planning (3) I (Identical with M.A.P. 506)
507. Social Service Planning (3) I (Identical with M.A.P. 507)
510. Development of Regional Planning (3) I (Identical with Geog. 510)
544. Site Planning (II) I (Identical with Geog. 544)
550. Metropolitan and Regional Planning (3) I (Identical with Geog. 550)
553. Location Analysis (3) I (Identical with Geog. 553)
556. Urban Systems Analysis (3) I (Identical with Geog. 556)
557. Statistical Techniques in Geography and Planning (3) I (Identical with Geog. 557)
561. Resource Management (3) II (Identical with Geog. 561)
563. Perception of Environment (3) II I (Identical with Geog. 563)
565. Project Planning and Modelling (3) II (Identical with C.E. 565)
567. Geographical Analysis of Population (3) I (Identical with Geog. 567)
568. Urban Transportation Planning (3) II (Identical with C.E. 568)
571. Problems in Regional Development (3) II I (Identical with Geog. 571)
573. Geology and the Urban Environment (3) II (Identical with Geos. 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
  a. Interdisciplinary Environment-Behavior Design (3) II (Identical with Env. 596, which is home)
  b. Architectural Design (3-8) I (Identical with Arch. 597a, which is home)
  c. Community Design for Non-Designers (3) I (Identical with Arch. 597i, which is home)
  d. Community Design (2) II (Identical with M.A.P. 602)
602. Analytic Methods in Planning and Management (3) II (Identical with M.A.P. 602)
605. Planning Theories and Perspectives (3) I (Identical with Geog. 605)
609. Policy Problems in Structure and Change (3) II (Identical with M.A.P. 609)
611. Projects in Regional Planning (1-5) II (Identical with M.A.P. 612a -612b)
612a-612b. Projects in Policy and Planning (2-3) II (Identical with M.A.P. 612a -612b)
615. Health and Public Policy (3) II (Identical with M.A.P. 615)
655. Efficiency Analysis in Health Administration (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) II (Identical with M.A.P. 662)
665. Quick Response Transportation Planning Methods (3) II (Identical with C.E. 665)
668. Urban Public Transportation Systems (3) II 1992 -93 (Identical with C.E. 668)
669. Preservation of Historic Environments (3) II 1992 -93 Current planning and legal methods to enhance the preservation of historic urban areas and structures; concentrated analysis of selected case studies. Field trips.
693. Internship
  a. Policy and Planning (1-4) S (Identical with M.A.P. 693g, which is home)
696. Seminar
  a. Land-Use Regulation (3) II (Identical with M.A.P. 696h, which is home)
  b. Legal Inquiry in Policy and Planning (3) II (Identical with M.A.P. 696i, which is home)
  c. Environmental Planning (3) II (Identical with M.A.P. 696j, which is home)
  d. Planning Administration (3) II (Identical with M.A.P. 696k, which is home)
  e. The General Plan (3) II (Identical with Geog. 696o, which is home)
  f. The Land Development Process (3) II (Identical with Geog. 696p, which is home)

**Plant Pathology (PLP)**

Forbes Building, Room 104 (602) 621-1828


The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in plant pathology. Conceptualizations are available in botany, mycology, nematology, virology, physiology of parasitism, genetics of pathogens, diseases of economically important plants and soilborne fungi.

Applicants should have a background in the biological sciences and undergraduate credit in college algebra and trigonometry (calculus is also recommended), microbiology, genetics, physics, two semesters of organic chemistry, and biochemistry.

At least fifteen units in plant pathology must be completed for the master's degree. A decision to require or waive the requirement for a master's degree thesis will be made after consideration of the student's preparation, proposed graduate program, and professional objectives.

For information concerning the Doctor of Philosophy degree see Requirements for Doctors' Degrees/Doctor of Philosophy elsewhere in this catalog.

516. Plant Nematology (3) II 1992-93 Comprehensive course in plant nematology, including the nature, ecology, and classification of plant parasitic nematodes. Diagnosis and control of nematode diseases of plants. 2R, 3L, P. 205.

551. Biology and Characterization of Plant Pathogenic Agents (4) I To acquaint students with the biological properties of the various groups of plant pathogens and with the contemporary methods used to characterize these agents and diagnose the diseases they cause. 3R, 3L, P. 205. (Identical with Micr. 551)

575a-575b. General Mycology (3-3) I-3 1992-93 Comprehensive study of fungi, including their structure, function, classification, genetics, and ecological importance. 575a: Basidiomycetes and Fungi Imperfect. 575b: Ascomycetes, Phycomycetes, and Actinomycetes. 2R, 3L, P. Ecol. 104 or Pr.S. 100. 575a is not prerequisite to 575b.

596. Seminar
  a. Current Research (1-3) I


621. Molecular Plant-Microbe Interactions (3) II 1992-93 Molecular properties that control development of host, parasite, and symbiotic relationships. Contemporary molecular hypotheses are related to genetic and biochemical data available on disease resistance and pathogenesis. P. Bioc. 460. (Identical with Bioc. 621 and M.C.B. 621)

694. Practicum
  b. Teaching Techniques in Plant Pathology (1-3) II P R. 451.

*May be convened with 400-level course.*
Plant Sciences (PLS)

Forbes Building, Room 201
(602) 621-1977


Associate Professors Hans J. Bohnert (Molecular and Cellular Biology; Professor, Biochemistry), Timothy G. Helentjaris, Dennis T. Ray, Steven E. Smith, Judith A. Verbeke

Assistant Professors Dean Della Penna, Fredric R. Lehle, Charles F. Mancino, William B. Miller, Karen K. Oishi

In addition to a commitment to prepare undergraduate students for careers after graduation, the department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in agronomy and plant genetics or in horticulture. Specific areas of research emphasis include genetics/horticulture with aspects of plant production, genetics both as the study of genomic structure and function as well as its more applied use for the improvement of crop plants, plant growth and development, and physiology and cell biology. The department encourages students to integrate the more classical aspects of these areas with recent innovations in order to develop both breadth and depth in the field of plant sciences during their graduate studies. The ready availability of modern laboratories, field space, and greenhouses within the department insures that students will not be hindered in their research efforts by facility constraints.

During their tenure all graduate students will take a core set of advanced courses including plant physiology, genetics, and anatomy and are expected to participate in departmental teaching and seminar programs. The needs and goals of individual students will determine subsequent course work from the various departments on campus. For their own research programs, students should select an area of specific interest to the faculty which will eventually lead to the preparation of a thesis. Where appropriate, a terminal M.S. program without the requirement for thesis research but emphasizing a broader selection of course work in plant sciences and related areas is available. Admission to doctoral studies without prior completion of the M.S. degree will also be considered on an individual basis for interested candidates.

Applicants are expected to have completed a bachelor's degree and possess a good background in biology, chemistry, and mathematics. Under exceptional circumstances, candidates with specific deficiencies will be accepted into the program and required to remedy deficiencies early in their graduate studies. Applicants must submit scores from the Graduate Record Examination (GRE) for both the General Test and one advanced test in an appropriately related area. They should also arrange to have three letters of recommendation from individuals in a position to assess their potential as a graduate student sent to the department. Requests for information on additional requirements or further questions concerning the application process should be addressed to the Graduate Student Coordinator, Department of Plant Sciences. Individuals wishing to start in the fall semester are strongly encouraged to apply prior to February 15th, particularly if they desire financial assistance.

505.* Weed Science (3) I Principles and effects of controlling agronomic and horticultural weeds, with emphasis on chemical control methods; weed identification. 2R, 3L, P. 460.

508.* Arid Land Crop Ecology (3) II Physical and biotic environment of crops in relation to crop culture, production, and geographical distribution; relations among the human population, crop productivity, and man's environment. P. 460.

509. Information Sources for Agricultural Scientists (1) I Information systems retrieval techniques, with particular reference to concepts, uses and limitations; emphasis on abstracts, indexes, alerting services, journals and government documents. (Identical with Li.S. 509)

510. Plant Molecular Biology (3) II 1992-93 (Identical with Bioc. 510)

515.* Principles of Plant Breeding (3) I Application of the principles of genetics, botany and statistics to the improvement of plants. P. A.Ec. 539, Ecol. 510, and either 312 or Ecol. 320.

541. Economic Botany of Arid Lands (3) I 1991-92 Examines past, present, and potential future industries based on plant resources in arid lands. Survey of useful products from arid lands, their biosynthesis and physiological function, taxonomic and geographic sources, and their role in local and global economies. P. 460. (Identical with Ar.L. 541)


560.* Plant Physiology (4) I Introduction to water relations, photosynthesis, respiration, growth and development of higher plants. 3R, 3L, P. 312, Chem. 241a, 243a. (Identical with Ecol. 560 and M.C.B. 560)


563.* Plant-Water Relations (3) II Analytic approach to the study of water movement into and through plants; development of internal water deficits and their significance to physiological processes. P. 460. (Identical with Ws.M. 563)

564. Plant Growth and Development (3) II 1991-92 Selected topics in growth and development. P. 460. (Identical with M.C.B. 564)

568.* Plant Cell and Tissue Culture (3) II Principles and theory of callus induction, embryoid and plantlet regeneration, nutrient transport, protoplast culture and fusion and plant transformation. 2R, 3L, P. 312, 460.

569. Seminar a. Current Topics in Plant Biology (1) I II (Identical with Pl.P. 659a)

Political Science (POL)

Social Sciences Building, Room 315
(602) 621-7600

Professors James W. Clarke, Richard C. Cotner, Helen M. Ingram, Conrad F. Joyner, Paul Kelso (Emeritus), Clifford M. Lyle, Edward N. Muller, Jerrold G. Rusk, Lawrence A. Saff, John E. Schwarz, Michael P. Sullivan, Peter A. Toma (Emeritus), John C. Walheke (Emeritus), Allen S. Whiting, Edward J. Williams, Clifton E. Wilson (Emeritus)

Associate Professors John A. Garcia, Head, Phillip C. Chapman, Jeanne Nienaber-Clarke, John E. Crow, William J. Dixon, Jerrold D. Green, Donald R. Hall (Emeritus), Thomas M. Holm, Barbara Norrander, Daniel J. O'Neil, Lyn Ragsdale, Thomas J. Volgy

Assistant Professors Paul G. Buchanan, David Gibbs, Richard Jankowski, Deborah R. Mathieu, V. Spike Peterson, David Wilkins, John P. Willerton

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in political science. Concentrations are available in political theory, American political institutions, public policy, political behavior, international relations, American Indian policy studies, and comparative politics. The Master of Arts degree is designed as a basis for students who plan to continue into a Ph.D. program. In addition, the department also designs programs for students interested in government careers, community college teaching, or specialization in selected areas as...
policy and environment or for self-improvement. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree. For information concerning this degree see Requirements for Master's Degrees/Master of Education elsewhere in this catalog.

Applicants must submit scores on the Graduate Record Examination, two letters of recommendation, and the personal data called for on the department's information form. Applicants are also invited to submit any other evidence, including published materials, which they believe to be relevant to admission.

Programs are planned, in consultation with an advisory committee, around the student's principal area of interest, emphasizing one or more of the areas of concentration listed above.

**Degrees**

**Master of Arts:** Each student must specialize in either one or two of the six fields of concentration listed above and complete at least 30 units of course work with at least 24 units at the 500 and 600 levels. A supervised research paper is required and, depending upon the student's principal interest, reading knowledge of a foreign language may be required. The final master's examination will be based upon the chosen area or areas of concentration.

**Doctor of Philosophy:** In addition to an area of concentration, each student must prepare in two additional fields prior to the preliminary examination. Either two foreign languages or one foreign language at high proficiency or advanced training in methodology are required. Finally, each student must complete two supervised original research papers prior to taking the preliminary examination. The department may waive the requirement for a qualifying examination for a student who has received the master's degree at the University of Arizona.

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506. **Bureaucracy, Politics, and Policy** (3) I Description and analysis of the executive branch of government; how federal agencies capture policy-making; why bureaucracy develops; the rules of bureaucratic culture; who controls the administrative branch.

507. **Congress and American Politics** (3) 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 of the public. P. 102.

510. **Struggle for the Presidency** (3) I (Identical with Comm. 510)

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. P. 102, 160 or Phil. 110, 113, or 121.

522. **Early Modern Political Theory** (3) II Western political theory from Machiavelli to Marx. P. 102, 160 or Phil. 110, 113, or 121.

523. **Recent Political Thought** (3) I II Political theory from Marx to the present. P. 102, 160 or Phil. 110, 113, or 121.

526. **Cross-National Research Methods** (3) I (Identical with Soc. 526)

527. **Marxism and its Critics** (3) II A critical survey of the main currents of Marxism from Marx to the present.

531. **Political Culture and the Dynamics of Change in American Society** (3) II Examination of the manner in which attitudes about politics and political problems are acquired from exposure to music and television, and the manner in which such attitudes lead to political action. P. 102.

532. **Pressure Groups** (3) I Formation, structure, and place of pressure groups in the democratic society; the function of interest groups in the political process; problems of leadership, internal organization, and membership loyalties. P. 102.

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. P. 102. (Identical with Soc. 535)

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—of their minds and the way they learned to respond to the private authorities of their childhoods. P. 102, plus an introductory level course in psychology, sociology, or anthropology.

537. **Democracies, Emerging and Evolving** (3) I Causal analysis of conditions of stability and breakdown of democratic regimes with particular emphasis on the developing democracies of the third world. P. 102. (Identical with L.A.S. 537)

538a-538b. **Philosophy of Law** (3-3) (Identical with Phil. 538a-538b)

541. **Arab-Israeli Conflict** (3) II Traces the birth and growth of the Arab-Israeli conflict since 1948 with particular attention to the internal impediments to conflict resolution on both the Arab and Israeli sides. Also surveys the role of the Great Powers in Middle East politics generally. P. 102.

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

543. **Soviet Politics** (3) I Revolution and contemporary ideology; state, party, and mass organizations; economic and social planning; civil liberties; models of authoritarian and pluralism. P. 102.

544. **East European Politics** (3) II Divergent models of Communist development, from East Germany to Yugoslavia; political, economic, social, and cultural reform. P. 102.

545. **Comparative Political Revolution** (3) I Examination of the causes and consequences of 20th-century revolutions and the revolutionary process, with emphasis on contemporary events.

547. **Latin-American Political Development** (3) II Presentation of strategies for development in Latin America; examination of case studies from Cuba, Brazil, Chile, Guatemala, and other countries. P. 102. (Identical with L.A.S. 547)

548. **Government and Politics of Mexico** (3) I Description and analysis of Mexico's political economy, its political system, and its foreign policy, with emphasis on Mexican-U.S. relations. P. 102. (Identical with L.A.S. 548)

549. **The Politics of Cultural Conflict** (3) II Comparative examination of the approaches of different political systems to domestic conflict of a racial, religious, lingual, and/or ethnic nature. P. 102.


551. **Soviet Foreign Policy** (3) I Ends and means of Soviet foreign policy; the decision-making process; Soviet relations with the West and developing nations. P. 102.

552. **Communist Foreign Relations** (3) II Interrelations of fourteen Communist-party states, with emphasis on cooperation and conflict in such organizations as the Comecon and the Warsaw Pact. P. 102.

554. **Theories of International Relations** (3) I Introduction to theories of international relations on the level of man, the nation-state, and the international system, with a logical and empirical evaluation of approaches and theories. P. 102, 120 or 250, 247.

555. **American Foreign Policy** (3) I Analysis of the Cold War; Congressional-Executive decision-making processes over foreign policy control; approaches to policy analysis. P. 102.

556. **International Law** (3) I The international state system; legal-political problems, including territory, environment, seas. P. 102, 120, or 250.

557. **Inter-American Politics** (3) II Survey and analysis of the leading political and economic issues at controversy between the United States and Latin America. P. 102. (Identical with L.A.S. 557)

559. **Problems of World Order** (3) II Analysis of complex, interconnected global problems, threats to survival, quality of life, and exploration of past and present policies and futures. Course is value-oriented and prescriptive. P. 102.

560. **Modern Chinese Foreign Relations** (3) II Survey of the developments and trends in Chinese foreign relations in the modern period, focusing mainly on the relationship between the theoretical and actual objectives of China's foreign policies from 1949 to the present. (Identical with Chn. 560)

564. **International Relations of East Asia** (3) II National interests, issues and conflicts, relations, and influence of domestic politics in interstate relations in East Asia. P. 102. (Identical with E.A.S. 564)

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


571. **Constitutional Law: Civil Liberties** (3) I II Analysis of the constitutional guarantees of civil liberties in the U.S. P. 102.
574. * Administrative Law (3) I Law governing the organization, powers, and procedures of the executive and administrative establishment, with emphasis on the limitations imposed by the American constitutional system. P. 102.

575. * Women and the Law (3) I Legal status of women in America, including constitutional protections, marriage and family relationships, educational and vocational opportunities, political rights, criminal law. P. 102.

576. Seminar (5) I, II The place of women in society, political, social, and economic developments in nations.

577. Research Design (4) I Introduction to experimental and quasi-experimental research design; survey research; the use of aggregate statistics; historical documents and life-history materials; participant observation; unobtrusive methods.

580. Methods of Political Inquiry (3) II Systematic examination of problems of scope and methods of inquiry in the discipline of political science; intended to acquaint students with the discipline and to prepare them for scholarly research in the field.

581. * Environmental Policy (3) II Role of government in management of energy, natural resources and environment; process and policy alternatives; special attention to the Southwest. P. 102. (Identical with H.W.R. 581 and R.N.R. 581)

582. Research and Methodology (4) II Quantitative techniques and computer applications in political science.


584a-584b. * Development of Federal Indian Policy (3-3) 584a: European colonial precedents through the treaty-making period. P. 334. 584b: End of treaty-making to the present. P. 334. 584a is not prerequisite to 584b. (Identical with A.In.S. 584a-584b)

585. Political Risk and Intelligence Analysis (3) II Examination of political risk and intelligence analysis with emphasis on forecasting political developments in nations.

586. * Political Systems of India and Pakistan (3) II (Identical with N.E.S. 586)


592. Research and Methodology (4) II Qualitative techniques and computer applications in political science.


594a-594b. * Development of Federal Indian Policy (3-3) 594a: European colonial precedents through the treaty-making period. P. 334. 594b: End of treaty-making to the present. P. 334. 594a is not prerequisite to 594b. (Identical with A.In.S. 594a-594b)

595. Political Risk and Intelligence Analysis (3) II Examination of political risk and intelligence analysis with emphasis on forecasting political developments in nations.

596. * Political Systems of India and Pakistan (3) II (Identical with N.E.S. 596)


598. Seminar (5) I, II The place of women in society, political, social, and economic developments in nations.

599. Research and Methodology (4) II Quantitative techniques and computer applications in political science.

600a-600b. * Current Issues in Psychological Theory and Research (3-3) Intensive examination of a range of content areas addressed in contemporary psychological theory and research. Open to psychology graduate students only.

601. * Biological Bases of Motivation (3) I Biochemical compounds related to life and the role of behavior in life; chemical processes occurring within organisms and how they interact with behavior. P. 101, 302 or 8 units of biological laboratory science.

602. Principles of Neuroanatomy (4) I (Identical with Anat. 502)

603. * Laboratory in Mammalian Systems Neurophysiology (3) II Neurophysiology laboratory including studies of micro-electrode recording of neural signals, electrical and chemical stimulation, and principles of analog and digital signal processing. P. 101, 255, 302.


605a-607b. Statistical Methods in Psychological Research (3-3) Statistical research design, methods and metascience. Both semesters include an introduction to computerized analytical techniques and software commonly applied in psychological research, such as SAS, SPSSX, BMDP, and EQS. 507a: Bivariate and multiple regression, application of structural equations modeling to manifest variable (path analysis) and latent variable (multivariate) causal analysis. 507b: Application of the general linear model to analysis of variance, covariance and multiple comparisons, exploratory and confirmatory factor analysis, the canonical correlation, discriminant function analysis and multivariate analysis of variance. Open to majors only.

608. Methods for Field Research (3) I II Research problems and methods particularly relevant to field research. The logic of inquiry and approaches to data analysis appropriate to field trials and quasi-experimental research.

609. History of Psychological Theories and Research (3) II Development of psychology as a science; schools, systems, theories, major advances, famous investigators.

610. * 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 emphasis on social cognition, social and emotional growth. P, 255, 314.

515.* Cognitive Development (3) II Introduction to major theories, methods, and research findings associated with the development of cognition and intelligence. P, 255, 313.

516.* Advanced Personality (3) II Advanced study of theories of personality; methods and results of personality study. P, 255, 316.

518.* Abnormal Psychology (3) II Nature and etiology of various forms of behavior disorder, mental deficiency, and other deviations; critical evaluation of current theories. P, 255.

519.* Field-Based Human Learning (3) II Learning principles in terms of behavioral ecology. Naturalistic study with video and computer methods of human services and academic settings. P. 101, 370.

520. Neurobiology (3) 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) II Basic concepts in psychology of death and loss, with emphasis on both the adjustment to death and loss, and the underlying phenomenological, humanistic and current social considerations. P, 255 or graduate standing.

522. Psychobiology (3) II Recent advances in psychobiology, with a strong emphasis on the neural bases of sensation, perception, motivation, emotion, and action.

524. Animal Behavior (3) 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) II Recent advances in analysis of the neural bases of cognitive functions, such as learning, memory, and thinking.

530.* Psychology, Law and Social Policy (3) II Critical review of theory, methods, and research in the psychology, law and social policy interface.

531.* Ethical Issues in Psychology (3) II A consideration of issues in the derivation of ethical criteria, selection of the appropriate subset of criteria to guide ethical decision-making, and utilization of the criteria when making a decision.

532. Conflict and Cooperation in the Dyad (3) I (Identical with M.A.P. 532).

535. Adult Development and Aging (3) I Change and continuity in cognition, personality, and adjustment during adulthood, with emphasis on aging processes and late life. P, 255, or 101 and two courses in gerontology or human development; or graduate standing. (Identical with Gero. 535).

537.* Gerontology: A Multidisciplinary Perspective (3) II Biological, psychological, and social issues in aging, including brain changes with age, cognitive change with age, and the social impact of increasingly older population demographics.

540. Perception and Attention (3) II Recent advances in the areas of perception and attention, with an emphasis on visual process.

542. Psycholinguistics (3) 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.

544. Cognitive Neuropsychology (3) II Recent advances in the area of cognitive neuropsychology, with an emphasis on the contributions of the brain to cognitive activities including memory, thinking, learning, and perceiving.

545. Interactive Behavior in Small Groups (3) II (Identical with M.A.P. 545).

546.* Environmental Cognition (3) 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.* Lexical and Syntactic Development (3) II Current theory and data on first language acquisition with special focus on research that relates linguistic theory and learnability theory to empirical studies of children's linguistic abilities.

554.* Culture and Mental Health (3) II Mental health in cross-cultural perspective; universal and culture specific disorders, traditional and western psychotherapy, cultural values in treatment methods and in research. P, 101, 418.

558.* Psychopathology (3) II In-depth study of current theoretical and research formulations in behavior deviancy; various approaches to behavior change. P, 255.

562. Mental Health Policy (3) II Major issues in law and mental health, including law and policies relating to the clients and providers of mental health services, and the organization/structure of the system for delivering these services.

565.* Neural Encoding, Memory and Computation in the Mammalian Brain (3) II Theoretical and biological mechanisms by which information is represented, categorized, stored, and recalled in specific central nervous system (CNS) circuits in the course of adaptive behavior. P, one advanced course in neuroscience, biological or cognitive psychology, one advanced course in math or computer science.


572.* Human Memory and Cognition (3) II Human learning, memory, and cognition; emphasis on information-processing approach to results and theory. P, 290, 370; or graduate standing.

573.* Natural Language Processing (3) II (Identical with Ling. 573).

575.* History of Psychology (3) I Growth of psychology as a science; major schools and theories; contributions of famous investigators and major advances; psychology as an art and a science today. P, 255 and 6 upper-division units in psychology.

578.* Sleep and Sleep Disorders (3) II Topics include sleep-wake rhythms, sleep deprivation, dreams, and the diagnosis and treatment of sleep disorders. P, 290, 302.

579.* Topics in the Cognitive and Affective Bases of Behavior (3) II Variable content (consult schedule); learning, cognition, perception, psycholinguistics, emotion, others. P, 255 and 6 units of upper-division psychology; or graduate standing.

580. Clinical Neuropsychology (3) I II Cognitive and affective sequelae of human central nervous system disease/damage, with emphasis on clinical evaluation, management and rehabilitation.

582. Psychopathology (3) I II Advanced survey of current theory and research in symptoms, causes and treatment of the major psychological disorders.

584.* Psychology and Health (3) II Current research and theory concerning psychological contributions to health maintenance, illness prevention and treatment, and the organization of health services.

585.* Contemporary Issues in Psychology (3) II Variable content (consult schedule); major topical problems in psychological research, theory, and applications. P, 255 and 6 units of upper-division psychology; or graduate standing.


588.* Computational Linguistics (3) I (Identical with Ling. 588).

*May be convened with 400-level course.

596. Seminar (3) I May be convened with 400-level course.

598. Seminar (3) I May be convened with 400-level course.
for positions of leadership in public sector and which is designed to prepare men and women offers the Master of Public Administration, The School of Public Administration and Policy Assistant Professors Susan Gonzales Baker Associate Professors H. Brinton Milward, Director Professors Michael Gottfredson (Management and Policy), Arid Lands Resource Sciences), John W. Olsen (Agriculture, Business and Public Administration, Engineering and Mines, Arts and Sciences; and in the Office of Arid Lands Studies and the Optical Sciences Center. Emphases are available in applied remote sensing or in remote sensing techniques.

Students electing the emphasis in applied remote sensing are required to complete at least twelve graduate units or Geog. 330 (without graduate credit and described in the General Catalog only) and ten graduate units. The program must include Opti. 550 and E.C.E. 531 and either Geog. 330, G.En. 507 or Env. 520. The remaining units may be selected from Ws.M. 522, Agrit. 453, E.C.E. 554, Geog. 553, or G.En. 507. Students electing the emphasis in techniques of remote sensing must complete twelve graduate units including Opti. 550 and E.C.E. 531. The remaining units may be selected from Opti. 504, 539, 552, 558, 559, 557; Atmo. 501, 656a-656b, 683. Students are urged to discuss the program with members of the Committee on Remote Sensing before selecting the courses to be taken. The program selected must be approved in advance by the committee.


Renewable Natural Resources (RNR/LAR/RAM/WSM/WFSC) Biological Sciences East, Room 325 (602) 621-7255


Associate Professors Michael T. Deeter, Gordon S. Lehman, Donald V. Lightner (Veterinary Sciences), R. William Mannan, William J. Matter, E. Gregory McPherson, Bruce A. Roundy, E. Lamar Smith, Donald C. Wilkin Assistant Professors Lee A. Graham, Lisa J. Graumlich (Tree-Ring Laboratory), D. Philip Guertin, Robert M. Itami, Vicente L. Lopes,
Mitchel P. McClaran, Guy R. McPherson, Thomas W. Swetnam (Tree-Ring Laboratory)

The School of Renewable Natural Resources offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in watershed management, range management, wildlife and fisheries science, and renewable natural resources studies. The school also offers a program leading to the Master of Landscape Architecture degree. For information concerning this degree see Requirements for Master's Degrees/Master of Landscape Architecture elsewhere in this catalog.

Applicants for the Master of Science and the Doctor of Philosophy degree programs are required to submit three letters of recommendation and scores on the Graduate Record Examination. For information concerning the doctor's degree, see Requirements for Doctor's Degrees/Doctor of Philosophy elsewhere in this catalog.

Graduate programs are individually planned after consideration of the student's preparation, area of interest, and career objectives. The purpose of the programs is to train people (1) for research and teaching in the area of natural resource management and planning, and (2) for land management positions requiring specialization in one of the available majors. All students are urged to gain a broad understanding of the social and political institutions as they affect fundamental relations of humans and their environment, particularly those involving plants, animals, soil, and climate.

Majors

Watershed Management or Range Management:

Concentrations are available in watershed hydrology, natural resource recreation, forest-watershed management, dryland forestry, and range science. Applicants should normally have completed an undergraduate major in watershed management, range management, natural resource recreation, or forestry with training in the biological, physical, and social sciences equivalent to that required for the bachelor's degree at the University of Arizona. Applicants lacking these prerequisites will be required to complete additional units in established watershed management, range management, or natural resource recreation courses.

Students working toward the Master of Science degree may select either of two plans: (1) complete at least thirty units including a thesis for which as many as five units may be earned, or (2) complete at least thirty units including an acceptable professional paper for which as many as three units may be earned.

Wildlife and Fisheries Science: This major includes specializations in wildlife ecology and fisheries science. Both programs require the completion of at least 30 units including a minimum of fifteen units of course work and an acceptable paper (thesis or professional paper) in the major's degree, with the approval of the student's advisory committee, plus preparation of an acceptable professional paper for which six units of credit may be earned.

Renewable Natural Resources Studies:

Graduate work in this major provides training and research opportunities in natural resources in combination with studies in areas such as planning policy, administration, economics and behavioral science. This interdisciplinary program is appropriate for continuing students and mid-career professionals interested in careers in natural resources policy administration, planning, management and research. Students should have academic training in one of the resource disciplines within the school or a related area. The master's degree requires at least 36 units including a thesis or professional paper for which six units may be earned.

Renewable Natural Resources (RNR)

517.* Introduction to Geographic Information Systems (3) II Computer techniques for capture, processing, analysis, and display of geographic information, with emphasis on applications in land resources management and planning. 2R, 3L. P. basic knowledge of computer operations. (Identical with Geog. 517 and S.W. 517)

538.* Fire Ecology (3) II Ecological role and use of prescribed fire in forest and range ecosystems; fire history; concepts and specific fire effects on vegetation, wildlife, soils and watersheds. P. basic ecology course, 316 or Ra.M. 382.

546. Principles of Research (3) II Philosophy of science and the principles of conducting research, including formulation of problems, problem analysis, study plans, and preparation of manuscripts for publication.

575.* Economics of Land and Water in the American West (3) II (Identical with A.Ec. 575)

576. Advanced Natural Resource Economics (3) II (Identical with A.Ec. 576)

578.* Global Change (3) II (Identical with Geos. 578)

580.* Natural Resources-Policy and Administration (3) II Resource policy formation; ethics of resource use; administration and organization for resource management; analysis of present policy and trends. P. 200, A.Ec. 476.

581.* Environmental Policy (3) II (Identical with Pol. 581)


586a-586b.* Advanced Environmental Interpretation (2-2) Advanced training and experience in communication of natural history and environmental principles to the public. Students must be available for some weekend field work. Field trips. P. 12 units in biology or renewable natural resources.

595. Colloquium

b. Public Natural Resource Management (2) II 1992-93

c. Human Dimensions in Renewable Natural Resources (3) I 1991-92

d. Topics in Forest and Range Ecology (2) II 1992-93

e. Heritage Resources Planning and Management (2) II 1991-92

596. Seminar

i. Water and Equity in the Southwest (3) [Rpt./2] I (Identical with Pol. 596i)

597. Workshop

a. Natural Resource Conservation Workshop (1) [Rpt./2] S Field trips.

b. Desert Ecosystems (1) [Rpt./3] II

*May be convened with 400-level course.

694. Practicum

a. Teaching in Renewable Natural Resource Studies (1-3) [Rpt./4 units] II

b. Teaching in Range Management (1-3) [Rpt./4 units] II

c. Teaching in Watershed Management (1-3) [Rpt./4 units] II

d. Teaching in Wildlife and Fisheries Science (1-3) [Rpt./4 units] II

696. Seminar

a. Renewable Natural Resources (1-2) [Rpt./1] II

697. Workshop

a. Interdisciplinary Problem Solving in Natural Resources I (2) II P, consult department before enrolling. (Identical with H.W.R. 679a, which is home) Note: 679a is part of a two-semester sequence. Students receive a grade of "K" at the end of the first semester. Credit and grade for 679a will be awarded only upon completion of 679b.

b. Interdisciplinary Problem Solving in Natural Resources II (2) II P 679a. (Identical with H.W.R. 679b, which is home) Note: 679b is part of a two-semester sequence. Credit and grade for 679b will be awarded only upon completion of 679b.

Landscape Resources

William H. Havens, Program Leader

Landscape Architecture (LAR)

501.* Landscape Planning and Design (4) I Planning and design problems at site scale with particular concern for conservation and energy utilization. 1R, 8S. P. 302.

502.* Regional Landscape Planning and Design (4) II Planning and design problems of regional scope and emphasis. 1R, 8S. P. 401.

507.* The American Landscape (3) II (Identical with Geog. 507)

522a-522b. Advanced Landscape Design (4-4) II 1992-93 Issues and problems in urban landscape design. Relationships with architects and engineers are stressed. Field trips.

522h: 1991-92 Issues and problems in urban landscape design which are directed toward urban fringe and to urban and regional systems. Relationships with city and county planners and planning and zoning procedures are stressed. 2R, 8L. Field trips. 522a is not prerequisite to 522b.

523a-523b. Advanced Landscape Planning (4-4) I 1992-93 Advanced techniques in
urban landscape planning and problem analysis including visual simulation, computer map overlay and video applications. 523b: 1991-92 Advanced techniques in rural landscape planning and problem analysis including applications of research in perception and behavior. 2R, 6L. 523a is not prerequisite to 523b.

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

533. Landscape Planning (2) I Theories and models in landscape planning; planning issues, methods, and case studies.

536. Urban Forestry (2) II 1991-92 Principles and practices of urban forestry, including vegetation structure and function, inventory and evaluation techniques, and planning-management approaches.

541.* History and Theory of Landscape Architecture (3) I Examination of the historical background and theoretical bases of landscape architecture.

550. Landscape Ecology (3) II Principles and theories of spatial ecology presented in the context of land management problems in Southern Arizona. Practical application of productivity theory emphasized. Field trips. 2R, 3L.

551.* Site Engineering (4) I Site layout, grading, drainage, earthwork calculations and road layout. 2R, 6L. Field trips. P, 250.

552.* Landscape Construction (4) I Introduction to construction materials and methods, working drawings and specifications related to the profession of landscape architecture. 2R, 5L, P, 451.

560. Professional Practice (3) II Professional services, contract documents, contract administration, office organization, ethics, professional registration, roles of the landscape architect, the practice of landscape architecture. P, 401.

595. Colloquium I Landscape Architecture Research (3) I

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

597. Workshop I Community Design for Non-Designers (3) I (Identical with Arch. 597I, which is home)

*May be convened with 400-level course.

694. Practicum I Landscape Architecture Teaching (1-2) I II

696. Seminar (1-3) I I a. Landscape Architecture (1) [Rpt.]

Range Resources

E. Lamar Smith, Program Leader

Range Management (RAM)

536.* Grazing Ecology and Management (2) I Application of animal diet and nutrition, grazing behavior, and vegetation-soil-herbivore interactions in management of grazing animals for improved livestock production, wildlife habitat, watershed protection, forest reproduction or other land use objectives. Includes design of water developments, fences and other structural range improvements.

546.* Range Vegetation Improvement (3) I Rangeland habitat manipulation through vegetation control and establishment including mechanical, chemical, and burning treatments. Re-vegetation techniques for rangeland and drastically disturbed semiarid lands. 2R, 3L. P, M.C.B. 181, Ecol. 182, S.W. 200.

556.* Rangeland Inventory and Monitoring (3) I Techniques of mapping and measuring attributes of vegetation and soils for inventory and monitoring of rangelands. Interpretation of data with respect to range condition and trend, watershed protection, value for livestock and wildlife habitat. P, R.N.R. 202, 321.

587.* Rangeland Management Plan (2) II Conduct a field inventory, develop management alternatives, and provide environmental and economic analyses of alternative management proposals in a written plan. 6L. All-day field trips. P, 456.

*May be convened with 400-level course.


596. Seminar a. Rangeland Management (1) [Rpt.] II

Watershed Resources

Richard H. Hawkins, Program Leader

Watershed Management (WSM)


508.* Wildland Fire Management (3) I Principles of fire behavior in forest, range and other vegetation types; interrelationships of fuels, weather, and topography; pyrolysis and combustion processes; effects of fire; fuels inventory; prevention; detection, and control techniques; fire danger rating and fire behavior modeling.

510.* Silviculture (3) II Principles and technical procedures for reproducing, planting, and tending forest crops, with reference to watershed. Weekend field trips. P, R.N.R. 316.


520.* Photogrammetry (1) I II 1992-93 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) I II 1992-93 Utilization and management of forest resources in dry environments; biophysical and socioeconomic issues related to the development of forest commodities and amenities. P, 6 units of upper-division Ws.M.

532. Agroforestry (3) I 1991-92 Ecological and socioeconomic factors related to the planning and implementation of agroforestry systems. P, 6 units of upper-division Ws.M.

534. Tree Nursery Management (3) I I 1992-93 Tree nursery establishment and management, with emphasis on dryland ecosystems. P, 6 units of upper-division Ws.M.

535. Water Management in Dryland Ecosystems (3) I I Hydrologic principles as applied to arid and semiarid ecosystems with water management applications in dryland resources management. P, A.Ec. 539, S.W. 201.


556. Quantitative dendrochronology (3) I 1992-93 (Identical with Geos. 556)

560. Watershed Hydrology (3) I I Application of fundamental principles to quantifying the basic hydrologic processes occurring on watersheds. P, Geos. 101, S.W. 200, 201; Stat. 160 or 263. (Identical with H.W.R. 560)

562. Watershed Management (3) I I Evaluating hydrologic impacts of management activities on watersheds to include silviculture, range, mining, and recreation use. 2R, 3L. P, 460.

563. Plant-Water Relations (3) I (Identical with P.L.S. 563)

564-564a.* Introduction to Dendrochronology (3-3) (Identical with Geos. 564a-564b)

565. Environmental Hydrochemistry (3) II 1992-93 (Identical with S.W. 565)

566. Botanical Basis of Dendrochronology (3) II 1991-92 (Identical with Geos. 566)

571.* Water Quality Control (3) II (Identical with C.E. 571)

*May be convened with 400-level course.

577. Natural Resource Economics and Public Policy (3) I I (Identical with A.Ec. 577)

595. Colloquium a. Non-Point Source Pollution from Watersheds (3) II P, 460.

599. Colloquium d. Fire Ecology (2) II 1992-93

655. Dendroclimatology (3) I I 1992-93 (Identical with Geos. 655)

696. Seminar a. Watershed Management (1-2) [Rpt.] II

Wildlife and Fisheries Resources

William W. Shaw, Program Leader

Wildlife and Fisheries Science (WFSC)

505.* Aquatic Entomology (3) I II 1992-93 (Identical with Ento. 505)

530. Principles of Nutrition (3) I I (Identical with An.S. 530)
Rhetoric, Composition and the Teaching of English
(See English)
The Committee on Second Language Acquisition and Teaching offers a program leading to a Doctor of Philosophy degree with a major in second language acquisition and teaching. The cooperating departments include Anthropology; East Asian Studies; English; French and Italian; German; Language, Reading and Culture; Linguistics; Near Eastern Studies; Psychology; Russian and Slavic Languages; Spanish and Portuguese; and Speech and Hearing Sciences. Students may choose from specializations in (1) second language analysis (grammar; contrastive linguistics/interlanguage studies), (2) second language use (discourse analysis; sociolinguistics; language and planning; rhetoric; pragmatics), (3) second language processes and learning (second/foreign language acquisition: theory and research), or (4) second language pedagogical theory and program administration (ESL/FL methods, curriculum development, testing and evaluation, reading and writing, educational technology).

Admission to the program is based on the following kinds of evidence: (1) excellent prior academic performance in a related field as indicated by a transcript; (2) three letters of recommendation from persons familiar with the student's performance; (3) an example of the student's scholarly writing on a topic related to the proposed area of study, or a critical review of a book which is relevant; and (4) GRE Aptitude test.

In addition, the TOEFL examination is required of foreign students. All students must demonstrate a thorough knowledge of one language other than English before advancement to candidacy, judged according to criteria and procedures established by the committee. Evidence of such second language proficiency including (but not limited to) a tape recording of speech in that language will be required prior to admission for all students applying for a graduate teaching assistantship.

Candidates for the Ph.D. will be required to complete a minimum of 78 units beyond the B.A./B.S. degree including 30 units of required courses, 18 units in one of the four areas of specialization, 12 units in a minor area of specialization, and 18 units of dissertation. It is anticipated that most students entering this degree program will hold the master's degree or its equivalent. Prior graduate level coursework which is judged by the committee to be comparable to required courses in this program may be counted toward the 78 total units. Core course requirements include linguistics, psycholinguistics, sociolinguistics, and research methodology, as well as second language acquisition theory and teaching practice. A detailed listing of courses and alternatives is available from the committee.

Prospective Ph.D. candidates must pass a qualifying examination no later than one year after entry into the program. Before formal admittance to candidacy all students must pass a preliminary examination in both the major and minor areas (culture, deviance and control, population and ecology, social interaction and socialization, social organization, and social stratification). If the minor is taken within the Department of Sociology, the student must write preliminary examinations in three of these areas. A final oral examination must be taken when all written examinations have been passed. The Ph.D. at this institution requires proficiency in any one of the following: a foreign language, mathematics, or computer science. Dissertations will generally be contributions to knowledge through original, empirical research.


503. *Sociometrics (3) I Social control of bodily process and structure, including social determinants of health. Both macro and sociopsychological theory and statistical research literature. P. upper-division standing and 3 units of social science or consult department before enrolling.

504. *Sociology of the Southwest (2) Populations, cultures, and social problems in their regional setting, with emphasis on the Southwest. P. 101 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 504 and Ainsi. 504)

505. World-System Theory and Research (3) I I Theory and research on the modern world-system.

506. *Social Gerontology (3) II Social aspects of aging and retirement, with special reference to the United States. P. 9 units of sociology. *(Identical with Gero. 506)

508. Sociology of Culture (3) II Theory and research on the nature of cultural systems, cultural production and consumption, and strategies of interpretive analysis. P. consult with department before enrolling.

510. Political Sociology (3) Basic approaches in political sociology, with emphasis on the relationship of economic and political processes.

515. Social Movements and Collective Action (3) I I 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 well as recent and classical empirical work in the area. P. admission to graduate program or departmental approval.

520. *Communication and the Legal Process (3) I (Identical with Comm. 520)

522. *Complex Organizations (3) II Theories and research regarding large-scale organizations and their relations to the individual and society. P. 9 units of sociology.

525. Organization Theory (3) Basic review of classic and contemporary approaches to the study of complex organizations; formation, development, and internal processes.
526. Cross-National Research Methods (3) II
Introduction to the logic and methods of cross-national social research. (Identical with Pol. 526)

530. Theories and Research in Social Psychology (3) A comprehensive introduction to the major theoretical perspectives, methodologies, research areas, and issues in contemporary social psychology.

531. Socialization and Society (3) II Various theoretical perspectives are applied to the content, process, and contexts of socialization throughout the life cycle to see how individuals become social beings and societal participants. P, 530, or consult department before enrolling.

532. Role, Self, and Identity (3) II An examination of the concepts of role, self, and identity in relation to social action and social psychological functioning. Alternative approaches are presented, but the symbolic interactionist perspective is highlighted. P, 530, or consult department before enrolling.

533. Social Relations, Groups, and Networks (3) I An analysis of social interaction in relations, groups, and networks, emphasizing the reciprocal influences of social structure and social process. Theories of exchange, power, status, and justice are considered. P, 530, or consult department before enrolling.

534.* Kinship and Social Organization (3) II (Identical with Anth. 534)
535.* Public Opinion and Voting Behavior (3) I II (Identical with Pol. 535)

536.* Social Structure and Personality (3) II Relation between the person and the group; social factors in character formation. P, 9 units of sociology.

540. Theories of Crime and Public Policy (3) I II (Identical with M.A.P. 540)

541. Deviance and Social Control (3) Basic critical review of traditional and contemporary concepts and formulations of deviance and social control; evaluation of contemporary research bearing upon deviance theory and informal and formal mechanisms of social control. P, 201, 341 or 342.

542.* Transformation of Agrarian Societies in the Middle East (3) II (Identical with N.E.S. 542)
550.* Social Stratification (3) I II Theories of social class, caste, and rank; social mobility in contemporary society. P, 9 units of sociology. (Identical with Anth. 550)

551. Stratification and Class (3) Basic examination of concepts and research in the area of stratification, with emphasis on the classic statements and contemporary research.

557. Gender and Labor (3) Sources and consequences of gender differentiation and inequality, with attention to occupations, earnings, labor markets, household work, and the family. P, 3 graduate credits in women's studies, sociology, or economics; or undergraduate major in one of these three fields.

558. Gender Identities and Interactions (3) Examination of the interface of gender, race, class, and ethnicity in the context of social structures and institutions. Focuses upon identities and social interaction as keys to understanding how gender inequality is created, perpetuated, or altered in families, schools, peer groups, work settings, and cultural symbols. P, 3 graduate credits in sociology, social psychology, or women's studies. (Identical with W.S. 558)

559.* Sociology of Gender (3) II Social construction, variation and consequences of gender categories across time and space. Topical (decision-making, deviance) and institutional (family, religion, politics) approaches. P, 101 or consult department before enrolling.

560. Intergroup Relations (3) Analysis of recent research on the relations among racial and ethnic groups in society, with special attention to current empirical and theoretical issues. P, 467.

567.* Race and Ethnic Relations (3) I II Social processes involved in minority groups in terms of race, caste, class, ethnicity, politics, and religion. P, 101 or 301; 6 additional units of sociology or anthropology. (Identical with A.A.S. 467, Anth., 567 and A.H.S. 567)

570a-570b. Social Statistics (3-3) 570a: Probability, distributions, estimation and hypothesis testing. 570b: Ordinary least squares regression, generalized least squares regression, structural equation models (path analysis and non-recursive systems).


580. Population Studies (3) I Theory and research in the fields of fertility, mortality, and migration, with emphasis on their relationships to social structure. An original research project is required.

585. Theory Construction in Sociology (3) I Sociological theories as alternative explanations. Classic and modern examples of working through the implications of alternative theories to formulate competing hypotheses for empirical tests. P, two courses in social science theory, preferably 500a-500b.

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)

*May be convened with 400-level course.

595. Colloquium a. Introduction to Graduate Study (1) I
596. Seminar a. Advanced Problems in Research (1-3) [Rpt.] II
b. Graduate Teaching (3) II 2R, 3L
c. Advanced Problems in Deviant Behavior (1-3) II
d. The Microfoundations of Macrosociology (3) [Rpt./7] I II P, 500a.
e. Social Organization (3) I [Rpt./6 units] P, completion of first-year graduate program curriculum in sociology. [Note: This is a two-semester course beginning in fall which requires a "K" grade at end of first semester]
f. Advanced Social Change (1-3) [Rpt.] II
g. Advanced Juvenile Delinquency (1-3) I II
h. Macrosociology (1-3) I II

Soil and Water Science (SW)
Shantz Building, Room 429
(602) 621-1646

Associate Professors David M. Hendricks, Alfred R. Huete, Allan D. Matthias
Assistant Professors Mark L. Brusseau, Raina L. Miller, 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 majors are available in soil fertility; soil chemistry; soil physics; soil microbiology; soil conservation; soil classification; water quality; irrigation; water resources development; waste management and pollution control in relation to soil, water, and air resources.

Students with adequate undergraduate preparation in engineering, physical sciences, or biological sciences will be considered for admission to an appropriate degree program.

A thesis is normally required, but the requirement may be waived for a student who is 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 semi-arid 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 (3) 1991-92 II Principles and procedures of chemical analysis of soils, water and biological materials with emphasis on instrumental techniques. 1R, 6L. P, Chem. 322, 323; Phys. 102b, 180b. Hendricks

507.* Hydrology of Unsaturated Media (3) I (Identical with H.W.R. 507)
511.* Soil Chemistry (3) I Soil chemical interactions with water, air, plants and pollutants. 2R, 3L. P, 200, Chem. 103b, 104b.

517.* Introduction to Geographic Information Systems (3) II (Identical with R.N.R. 517)


530. Environmental Measurements (3) II 1992-93 Theory and application of physical fundamentals, basic electronic circuits, transducers, data acquisition and computer-based analysis to environmental measurements. 2R, 3L. P, Phys. 102b. Simpson

531.* Soil Morphology, Classification and Survey (3) I Theory and practice of describing characteristics of soils; principles of soil classi-

541. Soil Genesis (3) | 1992-93 Physical and chemical processes and mineralogy of weathering and soil formation; quantitative pedology; the soil as part of the ecosystem. Field trips: 2 Geos. 101 and Chem. 103b. (Identical with Geos. 541) Hendrick

545. Advanced Soil Microbiology (2) | 1992-93 Interaction between soil organisms and roots and rhizosphere dynamics. Fate and detection of organisms added to soil. Advanced topics in soil microbiology. P, 435 or Micr. 425. (Identical with Micr. 545)

550.* Ambiguities of the Future: Focus on Environment (3) | Techniques to understand broad issues about the future with focus on environmental topics. Uses computer conferencing and significant student discussion with opportunities for team approaches and reporting.

553.* Remote Sensing of the Environment (3) | 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) | Consideration of major world soil and water conservation problems and solutions; principles of soil erosion by wind and water and their effects on world food problems. 2R, 3L. Field trips. P, 200. Post


570.* Soil Physics (3) | 1992-93 Soil structure and physical constitution of soils; the physical properties of soil-water systems, movement and exchange of gases in the soil, and physical laws governing the movement and availability of soil water. 2R, 3L. P, 200, Phys. 102b, CR, Math. 125a. Warrick


694. Practicum

696. Seminar
a. Topics in Soil, Water and Environmental Science (1) II

Southwest Studies

1052 N. Highland Avenue (602) 621-2484

The Southwest Center

Director Joseph C. Wilder

Southwest studies are designed to bring new perspectives to regional subjects through an interdisciplinary approach. Courses on the Southwest are taught through many university departments and programs, including American Indian studies, anthropology, English, geography, history, Latin American studies, linguistics, Mexican American studies, political science, sociology, Spanish and Portuguese, and women's studies. For information, contact the Southwest Center.

Spanish and Portuguese (SPAN/PORT)

Modern Languages Building Room 545 (602) 621-3123


The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Spanish. In cooperation with the College of Education, the department also offers work leading to the Master of Education degree with a major in Spanish; for information concerning this degree see Requirements for Master's Degrees in Master of Education elsewhere in this catalog. Through the graduate Committee on Medieval Studies, the department also collaborates in a program for the Doctor of Philosophy minor in medieval studies (see pertinent section of this catalog). Finally, it offers doctoral minors in Spanish and in 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 Master of Arts degree with the same major.

Degrees

Master of Arts (Major in Spanish): 33 units in one of four concentrations.

1. Hispanic literature program leading to doctoral studies: 33 units with equal concentration in Spanish and Spanish-American literature.

2. Hispanic literature program with area of 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 of pedagogy, 9 units of linguistics, 6 units of language, and 9 units of literature.

4. Hispanic studies (available in Guadalajara Summer School only): 21 units of Hispanic literature and no more than 12 units from supporting fields.

Doctor of Philosophy (Major in Spanish): 33 units of graduate course work beyond the Master of 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 the first semester of residency. Students are required to demonstrate knowledge of at least one foreign language other than Spanish at the third-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 total human knowledge.

Spanish (SPAN)

501. Literary Theory and Criticism (3) | 1992-93 Historical survey of theoretical writings on literature, with their implications for practical criticism.


506. Fifteenth Century Spanish Literature (3) | 1992-93 Traditional courtly and satiric literature; the Celestina. P, 420 or 503.


514. Teaching of Modern Languages (3) II (Identical with T.T.E. 514)


520. Realism and Naturalism (3) II 1992-93 Major prose writers of the 19th century from Galdos to Biscas Ibanez.

521. The Generation of '98 (3) I 1991-92 Major literary expressions concerning the problems of Spain and the Spaniard from the late 19th century to 1936.

522. Introduction to Romance Philology (3) I Survey of the development of the modern Romance tongues from the Latin language. P, knowledge of two Romance languages. (Identical with Fre. 522)

522a. Theory of Spanish Syntax (3-3) 522a: Introduction to current theories of syntax to describe specific phenomena. 522b: More detailed and further-ranging analysis of Spanish grammar within the general theory. P, 522a. (Identical with Ling. 523a-523b)

524. Contemporary Spanish Novel (3) I 1992-93 The novel since the Civil War.

525. Contemporary Spanish Poetry (3) II 1991-92

527. Applied Linguistics (3) I Application of linguistic theory, including psycholinguistic and sociolinguistic approaches to pedagogy. (Identical with Ling. 527)

528. Spanish-American Baroque (3) I 1991-92 Spanish-American works in the baroque or manerista literary current from the seventeenth and eighteenth centuries, largely in verse. P, 401a


535. Cervantes' Don Quixote (3) II P, 320.


545. Novel of the Mexican Revolution (3) I How the revolution of 1910 has been portrayed by Mexican leading writers. P, 320. (Identical with L.A.S. 545)


547. Contemporary Mexican Literature (3) II S Major novelists of modern Mexico; their works, narrative perspective, characterization, language, time, space, and themes. P, 320.


573. Spanish for the Native Speaker of Spanish Classroom Teacher (3) II Practical Spanish for the elementary and secondary school subject-matter teacher who uses Spanish as the medium of instruction. P, 303a or 329 or 330.

575a-575b-575c. Spanish-American Novel of the Twentieth Century (3-3-3) 575a: The 1920's. 575b: From 1930 to 1960. 575c: From 1960 to the present. No semester in this sequence is prerequisite to any other. P, 401b. (Identical with L.A.S. 575c)


578. Multimedia Approaches to Second Language Acquisition and Learning (3) II S Study of the theory and applications of media to the development of second language skills.

585. Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585) *May be converted with 400-level course.

596. Seminar

b. Methods of Literary Research (3) I 1991-92

m. Mexican-American Heritage Bibliography - A Library Seminar (3) [Rpt./6 units] I (Identical with M.A.S. 596m, which is home)


621. Spanish in the Americas (3) I 1992-93 (Identical with L.A.S. 621)

679a-679b. Techniques of Teaching College Spanish (3) I 1992-93: Theories of second language acquisition and teaching. 679b: Theories of second language evaluation. Units cannot be used to satisfy departmental graduate degree requirements.

696. Seminar

Portuguese (PORT)

549. * Brazilian Literature in Film (3) I 1992-93 The masterpieces of Brazilian literature and the great films based upon them. P, 301a or 301b. (Identical with L.A.S. 549)

554. * Studies in Portuguese Literature (3) II Major works, authors and tendencies in the literature of Portugal. P, 301a-301b.

*May be convened with 400-level course.

596. Seminar

- Mexican-American Heritage Bibliography—A Library Seminar (3) [Rpt./6 units] I (Identical with M.A.S. 596m, which is home)

698. Seminar

- Portuguese Literature (3) [Rpt.] II
- Brazilian Literature: 16th-18th Centuries (3) I II
- Brazilian Literature: 19th Century (3) I II
- Brazilian Literature: 20th Century (3) I II (Identical with L.A.S. 696)

Special Education

(See Special Education and Rehabilitation under Education)

Speech and Hearing Sciences (SPH)

Speech Building, Room 104
(602) 621-1644


Associate Professors Kathryn A. Bayles, Linda Swisher

Assistant Professors Jeannette D. Hoit, Ying-yong Qi

Director Anthony B. DeFeco (Speech-Language Clinic)

Assistant Director Kent J. Wilson (Speech-Language Clinic)

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in speech and hearing sciences.

Admission requirements include the completion of a minimum of 24 undergraduate units in speech and hearing sciences. Applicants must complete departmental application forms and submit three letters of recommendation. Scores on the aptitude test of the Graduate Record Examination are required of all applicants to the graduate program, and doctoral applicants must also submit a sample of their scholarly writing. Ordinarily, completion of the master's degree is prerequisite to admission to the doctoral program.

The Master of Science program requires the completion of 36 units of course work. Submission of a thesis as a part of the program is optional.

The Doctor of Philosophy degree is designed to provide the tools, knowledge, and experience in research and not to provide specialization in clinical pursuits.

500. Introduction to Quantitative Methods and Research in Speech and Hearing Sciences (2) I Study of measurement and research design and their application in research and professional practice.

501. Professional Issues in Speech-Language Pathology and Audiology (1) I Professional practice issues including certification, licensure, supervision, quality control, ethics, federal and state legislation.

502. Principles of Neuroanatomy (4) II (Identical with Anat. 502)

510. Counseling Techniques in Communication Disorders (3) I S Basic counseling techniques pertinent to clinical practice with the communication handicapped and their families.


553. Developmental Language Impairments (3) I Topics include: language and nonlanguage characteristics and clinical management of children with developmental language impairment, acquired aphasia, bilingualism and auditory disorders.

554. Adult Aphasia (3) II Etiology, evaluation and therapy for language disorders associated with brain damage. P, 370; 350 or 551.


558a-558b. Intermediate Clinical Studies: Speech-Language Pathology (1 to 3) II S Under faculty supervision, students assess speech and language functioning, develop treatment plans, and carry out remedial programs based on empirical data and current technology. 558b is an extern setting. Open to majors only. P, 551, 471.

559a-559b. Intermediate Clinical Studies: Audiology I-3 [Rpt./9 units] I II S Under faculty supervision, students assess hearing impairments, formulate objectives, and carry out remedial programs with emphasis on the application of research data and current technology to clinical treatment. Open to majors only. 559a is for majors concentrating in audiology; 559b for concentrating in speech-language pathology. P, or CR, 589.

560R.* Speech and Hearing Science Instrumentation (2) I Consideration of some common and specific instruments and methods employed in speech and hearing laboratories and clinics. P, 260, 280 or CR.

560L.* Speech and Hearing Science Instrumentation Laboratory (1) P, CR, 560R.

562. Psychophysical Acoustics (3) II Experimental procedures and instrumentation; study of psychoacoustics; stimulus integration, pitch and loudness limens and scales, masking, and auditory fatigue; binaural hearing; theory of signal detection. P, 280, 460.

563. Microcomputer Applications (2) II Basic understanding of microcomputer operations and its multiple functions; emphasis on computer literacy, administrative/computer applications and hands-on instruction.

567. Experimental Phonetics: Physiology (3) Systematic examination of current experimentation and research in speech as motor behavior, with emphasis on physiological investigations of normal respiration, phonation, resonance, and articulation; critical evaluation of research design. P, 260. (Identical with Psych. 567)

568. Experimental Phonetics: Acoustics and Perception (3) Systematic examination of current experimentation and research in speech as acoustical and perceptual phenomena; critical evaluation of research design. P, 260. (Identical with Psych. 568)

570R. Evaluation Process (2) I Study of principles, methods and selected procedures involved in the evaluation of individuals with communication disorders; attention to skills in interviewing and preparation of reports. P, 370, 483; CR or subsequent registration in 570L for majors.

570L. Laboratory in Evaluation Process (1) I II Open to majors only. P, 570R or CR.

571R.* Articulation Disorders and Therapies (2) I Etiology, diagnosis, prognosis, and therapy for the articulatory aspects of communication problems. P, 370; 367; CR or subsequent registration in 571L for majors.

571L.* Laboratory in Articulation Disorders (1) I Open to majors only. P, 571R or CR.


574. Cleft Palate, Other Craniofacial Disorders and Communication (2) I Communication disorders associated with cleft palate and other craniofacial defects. Speech assessment, evaluation and treatment; survey of dental and surgical services.


576. Communicative Aspects of Aging (2) I Hearing, speech, voice, and language changes in the elderly caused by aging and disease. Emphasis on management of these problems. (Identical with Gerol. 576)


579. Organization and Administration of Speech and Hearing Programs (3) II Problems in organizing a speech and hearing pro-
gram: philosophy, case load, space, staff, budget, interagency cooperation.

580. Community and Industrial Audiology (2) II Hearing conservation in industry, schools, and the community; auditory and non-auditory effects of noise, noise assessment, control, and protective procedures.


582. Hearing Disorders and Special Tests (4) II Pathologies of the hearing mechanism, and their auditory manifestations. Special audiological procedures to differentiate site of lesion.

583. Principles of Audiology (3) I Basic principles and techniques of audiological testing, etiologies of hearing impairment, and intervention strategies. P, 280 or graduate standing.

584. Audiologic Rehabilitation: Adults (3) II Speech reading; auditory training; problems encountered with amplification units; social, psychological, educational, speech, and language difficulties encountered by the hearing handicapped. P, 280, 483.


*May be convened with 400-level course.


589. Advanced Audiology Evaluation (3) I Principles and techniques of administering and interpreting the comprehensive audiologic evaluation. 3R, 3L. P, 260, 483.


596. Seminar a. Experimental Phonetics (1-3) [Rpt./2 or 9 units] III
b. Clinical Audiology (1-3) [Rpt./2 or 9 units] III
c. Hearing—Physiology and Psychophysics (1-3) [Rpt./2 or 9 units] III
d. Language and Language Disorders (1-3) [Rpt./2 or 9 units] III
e. Speech Pathology (1-3) [Rpt./2 or 9 units] III

600. Research Methods in Communication Sciences and Disorders (3) II Design and execution of descriptive and experimental research in communication sciences and disorders.

658a-658b. Advanced Clinical Studies: Speech-Language Pathology (1-3—1-3) [Rpt./9 units] II S With faculty consultation and supervision, students assume responsibility for all aspects of case management of children and adults. Exposure to clinical research methods and interdisciplinary staffing. 658b is in an extern setting. P, 471, 553.

569. Advanced Clinical Studies: Audiology (1-3) [Rpt./9 units] II S With faculty consultation and supervision, students assume responsibility for all aspects of case management of adults and children. Exposure to clinical research methods and interdisciplinary staffing. Open to majors only. P or CR, 589.

665R. Aerodynamic Evaluation and Management of the Speech Mechanism (2) II Principles and clinical methods of aerodynamic evaluation and management of the disordered speech mechanism, with practical experience provided through case studies and class experiments. P, 260, 460R/L, 567.


693. Internship a. Speech Pathology (1-6) I Open to majors only.
b. Audiology (1-6) I Open to majors only.

695. Colloquium a. Motor Control (2) [Rpt./8 units] I (Identical with Ex.S.S. 695a)

696. Seminar a. Experimental Phonetics (1-3) [Rpt./9 units] II
b. Clinical Audiology (1-3) [Rpt./9 units] II
c. Hearing—Physiology and Psychophysics (1-3) [Rpt./9 units] II
d. Language and Language Disorders (1-3) [Rpt./9 units] II
e. Speech Pathology (1-3) [Rpt./9 units] II

Speech Communication
(See Communication)

Statistics (STAT)
Economics Building, Room 317 (602) 621-4158
Professors Yashaswini Mittal, Head, J.L. Denny, Jean E. Weber
Associate Professor A. Larry Wright

The department offers a program leading to the Master of Science degree with a major in statistics. A thesis is not required, but up to 6 units may be earned by writing one.

The Master of Science degree requires 30 units of graduate-level courses, of which at least 18 units must be taken in the department. A thesis is not required, but up to 6 units may be earned by those who wish to write one.


563. Nonparametric Statistics (3) I Distribution free statistics, chi-square tests, related samples, independent samples, correlations, tests of significance, confidence bands. P one course in statistics.

564. Theory of Probability (3) I (Identical with Math. 564)

556. Statistics for the Medical Sciences (4) II Standard and nonparametric one- and two-sample procedures, ANOVA designs, linear and multiple regression, bioassay, probit analysis, and contingency tables. 3R, 3L. Not open to majors. P, two semesters of calculus. (Identical with Tox. 565)


568. Applied Stochastic Processes (3) II (Identical with Math. 568)

*May be convened with 400-level course.

596. Seminar a. Research Methods (1-4) [Rpt./6 units] II


663a-663b. Applied Statistics (3-3) 663a: I Analysis of variance, multiple regression components of variance, experimental design, failure of assumptions, randomization, exploratory data analysis. 663b: II Nonparametric methods, robust point and interval estimation, contingency tables, analysis of quantitative data, causal data, actual case histories.

664. Applied Multivariate Analysis (3) II Consideration of multivariate statistical analyses, with emphasis on applications, interpretation of computer printouts and effects of violations of model assumptions. P, 660.

665. Applied Time Series Analysis (3) I Methods used in time series analysis, with emphasis on applications, including computer analysis of data and consideration of violations of model assumptions. P, 660.

Systems and Industrial Engineering (SIE)
Engineering Building, Room 111 (602) 621-6551
Professors Pitu B. Mirchandani, Head, A. Terry Bahill, Lucien Duckstein, William R. Ferrell, Marcel F. Neuts, John S. Ramberg, Donald G. Schultz (Emeritus), Soroosh Sorooshian (Hydrology and Water Resources), Ferenc
The department offers programs leading to the Master of Science degree with majors in systems engineering, industrial engineering, and reliability engineering, and leading to the Doctor of Philosophy degree with a major in systems and industrial engineering.

Normally, the graduate student has a background in engineering, mathematics, or physics. In addition, a special program is available to students with bachelor's degrees in areas other than engineering or the physical sciences. Programs vary in length from one to two-and-one-half years, depending upon background.

The Master of Science degree consists of either 30 or 33 units. For the 30-unit program, at least 18 must be taken within the department. Additional master's-level options are available, including a 6-unit thesis, a 6-unit paper, or a 3-unit report, each of which requires an oral examination. The 33 unit program requires only course work, subject to the further requirement of one 600-level course and an oral final examination. Additional details concerning the requirements of the master's and doctor's degree may be obtained on request from the department.

507. Advanced Engineering Quality Control (3) II Advanced techniques for statistical quality assurance, including multivariate control charting, principal components analysis, economic design of acceptance sampling plans and control charts, inspection errors, and select papers from the recent literature. P. 530.

508. Reliability Engineering (3) I Time-to-failure, failure-rate, and reliability determination for early, useful and wear-out lives; equations and prediction; spare parts provisioning; reliability growth; reliability allocation. Credit for this course or A.M.E. 572, but not both. P, 408, 530.

522. Engineering Decision Making Under Uncertainty (3) I Application of principles of probability and statistics to the design and control of engineering systems in a random or uncertain environment. Emphasis is placed on Bayesian decision analysis. P. 330R-330L.

525. Queueing Theory (3) II Application of the theory of stochastic processes to queueing phenomena; introduction to semi-Markov processes; steady-state analysis of birth-death, Markovian, and general single- and multiple-channel queueing systems. P. 520.

528. Maintainability Engineering (3) II Complex systems reliability; maintainability engineering; reliability and availability of maintained systems; operational readiness; system effectiveness; maintainability demonstration. Credit for this course or A.M.E. 575, but not for both. P, 408, 530.


532. Statistical Models in Engineering (3) Statistical distributions applicable in engineering, with emphasis on quality and reliability problems. Topics include model selection, parameter estimation, and approximations for large-scale systems. P. 530.

536. Experiment Design for Engineering I (3) I Design and analysis of experiments for engineering design and manufacture. Topics include classical designs, Japanese approaches, analysis of variance and regression analysis. P. 530 or Stat. 566a.

537. Experiment Design for Engineering II (3) II Continuation of 536. Topics include response surface analysis, related empirical optimization methods, random effects models and nested designs. P. 536.


541. Dynamic Programming (3) II 1991-92 Application of the art and theory of dynamic programming to common stochastic and deterministic sequential decision problems, including equipment replacement, capacity expansion, inventory planning and decision analysis. P. 321, 340.


550. Theory of Linear Systems (3) II An intensive study of continuous and discrete linear systems from the state-space viewpoint, including criteria for observability, controllability, and minimal realizations; and optionally, aspects of optimal control, state feedback, and observer theory. P. 350.

551. Modeling Physiological Systems (3) Development and validation of models, sensitivity analyses, and applications of systems engineering techniques to physiological systems.


554. Mathematical Systems Engineering Design (3) I Tools for modeling and concurrent engineering of large-scale, complex systems: documentation, a system design language, quality function deployment, system coupling, subsystems, and homomorphisms.

558. Fuzzy Sets in Systems Analysis and Analysis, and Decision Making (3) I 1991-92 Fuzzy numbers' definition, operations; fuzzy regression, interpolation and reliability, fuzzy logic, optimization and control; fuzzy events and decision-making applications in areas such as systems, civil, industrial, electrical, computer engineering and water management.


564. Facilities Layout and Location (3) II Definition and solution of continuous and discrete, single and multifacility location problems for various objectives. Relative location of facilities for minimizing material handling and interaction costs. Emphasis on quantitative methods.
567. Advanced Production Control (3) II Quantitative models in the planning, analysis, and control of multi-level production systems. Topics include aggregate planning, inventory control, capacitated and uncapacitated lot-sizing, and Just-in-Time systems. P. 544, 321.


574. Expert Systems (3) I Building, testing and evaluating expert systems, computer systems that emulate the human and draw conclusions based on incomplete or inaccurate data. Each student will build an expert system using commercially available expert system shells. Familiarity with computers is required.

575. Computational Methods for Games, Decisions, and Artificial Intelligence (3) II An introduction to automata, computer representation and optimal solutions 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. Sc. 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.


May be convened with 400-level course.

608. Selected Topics in Reliability (3) I In-depth analysis of selected advanced topics in reliability engineering from the recent archival literature. Project required. P. 530, A.M.E. 577.

620. Selected Topics in Probability Modeling (3) II Unconstrained and constrained optimization problems from a numerical standpoint. Topics include variable metric methods, quadratic programming, active set methods, penalty function methods and successive quadratic programming methods. P. 544.

625. Advanced Queueing Theory (3) Study of complex queueing models of engineering interest. Emphasis on algorithmic methods for the study of such models. P. 525.

631. Digital Systems Simulation (3) Emphasis on current research problems including random variable generation, modeling, language development and statistical analysis of output. P. 431 or M.S. 521a or 521b.


645. Large-Scale Optimization (3) I 1992-93 Decomposition-coordination algorithms for large-scale mathematical programming problems where the decisions form a discrete set. Topics include model development, branch and bound methods, cutting plane methods, relaxations, computational complexity and solving well-structured problems. P. 544.

654. Mathematical Theory of System Design (3) II Formal presentation of the system design process of design requirements development and selection based on an evaluation of the applicant's professional potential, trainability, and talent. The program encompasses a rigorous regime of studio training, classroom study, and University Theatre productions. The program is designed to instill in the student the highest academic standards and professional skills required to initiate a career in educational and/or professional theatre.

The Department of Theatre Arts offers programs leading to the Master of Arts and the Master of Fine Arts degrees with a major in theatre arts. The Master of Arts is an academic degree with a critical emphasis. The Master of Fine Arts degree is a professional training program emphasizing artistic achievement. Admission is competitive and based on an evaluation of the applicant's professional potential, trainability, and talent. The program encompasses a rigorous regime of studio training, classroom study, and University Theatre productions.

In cooperation with the Department of Theatre Arts, the Committee on Dance offers a program of advanced study which leads to a Master of Arts in theatre arts with a dance concentration. For a listing of graduate courses, see Dance.

501. Advanced Stagecraft I (3) I Advanced studies in scenic construction methods and techniques. P. 111.

504. Musical Theatre III (3) I Intensive scene study and exploration of the major historical styles and genres of the American musical theatre. 2R, 2S. Open to majors only. P. 304 and audition.

514. Advanced Make-up (2) [Rpt.2] History and practical application of theatrical make-up. Design and construct such items as masks, prosthetic pieces, wigs and beards. P. 115.

515. Theatre Graphics II: Drafting (3) I Advanced theatrical perspective, scenographic and graphic techniques. P. 120.

516. Theatre Graphics III: Rendering (3) [Rpt.3] II Advanced practical color theory in pigment and illustration, rendering mediums and techniques. P. 120.
520. *Advanced Lighting Design I (3) II Special problems, practice and trends in designed light for theatrical productions. P. 220.

521.* Special Effects for Theatre (3) II Applied theory and techniques associated with sound system and visual effects in the theatre. 2R, 3L.

522.* Theatrical Properties (3) [Rpt./2] I 1991-92 Construction and collection of stage properties. Experimentation with the use of materials and techniques.


524.* Advanced Scenic Design I (3) I Advanced techniques and methods of scenic design. P. 223.


527. *Advanced Stage Costume Construction I (3) II Advanced techniques in costume construction including period pattern design, cutting and draping techniques. P. 116.

529.* Advanced Stage Costume Design I (3) I Advanced techniques in costume design. P. 116.

530. *Stage Management (2) I Principles and techniques of stage management, practical applications, problems and analysis of stage managing. P. 111, 151.

531.* Theatre Publicity and Box Office (3) I Publicity, press releases, sales, advertising, display techniques, subscription procedures. P. 12 units of theatre arts or related arts fields.

532. *Theatre Management (3) II Amateur, educational and professional theatre organization and management; theatrical contracts, professional unions and representative organizations. P. 12 units of theatre arts or related arts fields.


541. Scenography (3) The integration of scenery, costume, make-up, light and sound into a total production design.

542.* Advanced Stage Lighting II (3) I An advanced study of lighting design for opera and dance; theoretical (light plots) and practical (light lab) projects. P. 420/520.

543. Advanced Stage Lighting III (3) 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 1992-93 (Identical with Dnc. 546).

549.* Acting V (3) I Intensive study of classical acting styles with emphasis on Shakespeare. Individual and group performance. 2R, 2S, P. 251 and audition.


551.* Acting VI (3) I Intensive study of classical acting styles with emphasis on Commedia dell'arte, Moliere and English Restoration. Individual and group performance. 2R, 2S, P. 305, 449, audition.

552.* Acting VII (3) I [Rpt./1] Audition material, techniques and research into problems of a professional career in the theatre, television, motion pictures and related fields. 2R, 2S, P. 305, 449, audition.

553.* Acting VIII (3) II Intensive study 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 completed production; special attention given to director-actor, designer, and the production process. Direction of one-act plays. 2R, 2S. P. 455.

560a-560b.* Writing for Stage and Screen (3-3) Preparation and analysis of short scripts for stage and motion pictures.

561.* Artist Collaboration (2) [Rpt./2] II 1992-93 The development and communication of a visual idea for performance art; exploring all mediums of visual and aural communication.

565.* Dialects in Performance (3) Application of suitable phonetic theory toward a systems approach to acquiring dialects for performance in stage, television and radio presentations. 1R, 4S. P. ability to do close transcription in International Phonetic Alphabet (IPA).

575.* Screen Acting Techniques (3) II Principles and techniques of various performance methods involved in acting for television and motion pictures; basic problems faced by the professional actor seeking employment in these media; on camera experience with directed exercises and dramatic scenes. 2R, 3L. P. 151, audition.


596. Seminar d.* Dance-Related Art Forms (3) II 1992-93 (Identical with Dnc. 596d, which is 2R, 2S. P. 452/520.

597. Workshop a.* Technical Direction (1-6) [Rpt./20 units] I II S.

598. Workshop d.* Costume Design (1-6) [Rpt./20 units] I II S.

599. Workshop c.* Lighting Production (1-6) [Rpt./20 units] I II S.

600. Workshop d.* Sound Production (1-6) [Rpt./20 units] I II S.

601.* Scenic Production (1-6) [Rpt./20 units] I II S.

602. *Performance (1-6) [Rpt./20 units] I II S.

*May be convened with 400-level course.

600. Introduction to Graduate Study of Drama (3) I Methods and materials for research in theatre and drama; introduction to the bibliography of these fields; organization and form of thesis.

605. Advanced Voice and Movement for the Actor I (3) [Rpt./1] I Advanced study and exercise in voice and movement for the actor: relaxation, breathing, physical and vocal freedom, resonance, articulation and improvisation including the Linklater Approach, IPA, and Neutral Mask. 6S. P. audition.

606. Advanced Voice and Movement for the Actor II (3) [Rpt./1] II Continued advanced study and exercise in voice and movement for the actor: standard stage speech, stage dialects, period customs, manners and movement. 6S. P. audition.

640. Dramatic Criticism: Tragedy (3) I Comparative analysis of tragedy and theories of tragedy from antiquity to the present. Writing of critical papers.

641. Dramatic Criticism: Comedy (3) II Comparative analysis of comedy and comic theory from antiquity to the present for stage and screen; writing of critical papers.

642. Advanced Studies in Theatre History (3) I II Concentrated study in theatre history, with major emphasis on the physical theatre, standard scholarly works, and source materials.

644. History of the American Theatre (3) II Studies in the American theatre and drama. Directed and individual projects will be assigned.


651. Experimental Theatre II (3) II Theories and techniques of avant-garde theatre. Rehearsal and performance of select projects.

655. Advanced Directing I (3) I Techniques of stage directing, including play analysis, director-actor communication, director-designer communication, blocking, movement, composition; use of directorial style and the adaptation of directorial philosophies. 2R, 2S.

656. Advanced Directing II (3) II Techniques of analyzing and staging classical texts for a contemporary audience; use of directorial style and the adaptation of directorial philosophies with an emphasis on staging the plays of Shakespeare. 2R, 2S. P. 449, 655.

666.* Seminar a. Contemporary Trends (1-3) [Rpt./6 units] I II.

b. Special Topics in Acting (1-3) [Rpt./6 units] I II.

c. Special Topics in Directing (1-3) [Rpt./6 units] I II.

d. Musical Theatre Production (1-3) [Rpt./6 units] I II.

e. Special Topics in Playwriting (3) [Rpt./6 units] P. permission of instructor.

f. Film Editing (1-3) [Rpt./6 units] I II.

g. Documentary and Educational Films (1-3) [Rpt./6 units] I II.

h. Special Topics in Stage Costume Construction (1-3) [Rpt./6 units] I II.

i. Period Design Style (1-3) [Rpt./6 units] I II.

k. Special Topics in Scene Design (2-3) [Rpt./6 units] I II.

l. Special Topics in Costume Design (2-3) [Rpt./6 units] P. 424.

m. Special Topics in Stage Management (3-9) [Rpt./6 units] I II.

n. Special Topics in Lighting Design (2-3) [Rpt./6 units] P. 420.

*Students may earn a maximum of 9 units in T.A.R. 696, with a maximum of 5 units in any one area.
No advanced degree is offered in veterinary science. Cooperative arrangements may be made with the departments such as Animal Sciences, Entomology, Ecology and Evolutionary biology, Microbiology and Immunology, and the Committee on Physiological Sciences. 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. 418, 419; Chem. 243a; Math. 117R/S.

503L.* Parasitology Laboratory (1) l Parasite morphology and diagnostic laboratory techniques. P, 9 units of ecology or microbiology, CR, 503R. (Identical with Ecol. 503L, Ento. 503L and Micr. 503L)

505.* Animal Diseases (3) l Integration of management, husbandry, and preventive veterinary medicine, as related to animal diseases.

520R.* Pathogenic Bacteriology (3) II (Identical with Micr. 520R)

520L.* Pathogenic Bacteriology Laboratory (2) II (Identical with Micr. 520L)

523R.* General Pathology (3) II Pathogenesis, pathophysiology and morphologic changes of human and animal diseases. P, Micr. 420R. (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, 523R or CR. (Identical with Micr. 523L and Tox. 523L)

538.* Ecology of Infectious Disease (3) II Factors involved in the epidemiology of infectious diseases. P, 420R or 420L. (Identical with Micr. 538)

543.* Research Animal Methods (3) II Regulations, care, diseases and techniques involving common laboratory animals used in research and teaching programs. (Identical with An.S. 543, Bioc. 543, Micr. 543)

549.* Diseases of Wildlife (3) II An overview of disease processes and agents, immunology, epidemiology and regulatory species common to the Sonoran Desert and surrounding regions. (Identical with An.S. 549 and W.F.Sc. 549)

550R.* Medical Mycology (2) II (Identical with Micr. 550R)

550L.* Medical Mycology Laboratory (2) II (Identical with Micr. 550L)

552.* Medical-Veterinary Entomology (4) II [Rpt./3] II (Identical with Ento. 552)

555R. Fishery Management (3) II (Identical with W.F.Sc. 555R)

558.* Comparative Vertebrate Anatomy (4) II Evolution and gross structure of vertebrate organ systems. 2R, 6L. P, 8 units of animal biology. (Identical with Ecol. 558)

559.* Comparative Vertebrate Histology (4) II Identification, phylogeny, and function of normal vertebrate tissues. 2R, 6L. P, 12 units of animal biology. A vertebrate anatomy and/or systems course is strongly recommended. (Identical with Ecol. 559)

566.* Physiology Laboratory (2) II (Identical with Ecol. 566)

568.* Comparative Physiology (3) II (Identical with Ecol. 568)

601. Experimental Surgery (2) II 1991-92 Exercises in the surgical procedures commonly necessary in animal experimentation, including aseptic technique, anesthesiology, surgical operations, and care of the postsurgical patient. 1R, 3L. P, 3 units of mammalian anatomy.

630. Immunology (4) II 1992-93 (Identical with Micr. 630)

649. Fishery-Water Quality and Toxicology (3) II (Identical with W.F.Sc. 649)

Water Resources Administration
(See Hydrology and Water Resources)

Watershed Management
(See Renewable Natural Resources)

Wildlife and Fisheries Science
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Zoology
(See Molecular and Cellular Biology, Ecology and Evolutionary Biology)
## Graduate Programs at The University of Arizona

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Write: Career Services

Transcripts
Write: Student Information, Registration
and Records