GRADUATE CATALOG
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1990-91
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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Graduate Admissions Office
Administration 322
The University of Arizona
Tucson, Arizona 85721
(602) 621-3132

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  Architecture (Arch.)
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  Astronomy (Astr.)
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College of Architecture.

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

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

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

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

College of Law.

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

College of Nursing.

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

College of Public Affairs. Schools: School of Public Affairs. Divisions of: Community and Environmental Health; Medical Technology.

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

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

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

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

Extended University and the Summer Session.

The University Libraries.
Abbreviation Guide

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

a.ec.  agricultural economics
a.ed.  agricultural education
a.en.  agricultural engineering
a.m.e. aerospace and mechanical engineering
acct.  accounting
agri.  agriculture
A.In.s. American Indian studies
an.s.  animal sciences
anat.  anatomy
anes.  anesthesiology
anth.  anthropology
appl.  applied mathematics
ar.l.  aridlands resource sciences
arch.  architecture
art.  art
astr.  astronomy
atmo.  atmospheric sciences
b.ad.  business administration
bioc.  biochemistry
Bl.s.  Black studies
C.Bio.  cancer biology
c.e.  civil engineering
ch.e.  chemical engineering
chem.  chemistry
clas.  classics
comm.  communication
coun.  counseling and guidance
cp.l.t.  comparative literature and literary theory
crl.  critical languages
c.s.  consumer science
c.sc.  computer science
c.t.  clothing and textiles
dnc.  dance
dram.  drama
e.c.e.  electrical and computer engineering
e.m.  engineering mechanics
ecol.  ecology and evolutionary biology
ecn.  economics
ed.a.  educational administration
ed.p.  educational psychology
educ.  education
Engl.  English
engr.  engineering
ento.  entomology
ex.s.s.  exercise and sport science
f.c.m.  family and community medicine
f.c.r.  family and consumer resources
fin.  finance and real estate
Fre.  French
f.s.  family studies
g.en.  geological engineering
gen.  genetics
geog.  geography and regional development
geos.  geosciences
Ger.  German
gero.  gerontology
Grk.  Greek
h.ed.  higher education
h.e.e.  home economics education
hist.  history
hth.  health education
honr.  honors
h.p.sc.  history and philosophy of science
h.r.p.  health-related professions
hum.  humanities
hydr.  hydrology
i.d.  interior design
idis.  interdisciplinary
i.med.  internal medicine
Ital.  Italian
jour.  journalism
l.ar.  landscape architecture
<table>
<thead>
<tr>
<th>Abbreviation</th>
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<td>L.A.s.</td>
<td>Latin American studies</td>
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<td>language, reading, and culture</td>
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<td>m.c.b.</td>
<td>molecular and cellular biology</td>
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<td>med.</td>
<td>medicine (interdepartmental)</td>
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<td>microbiology and immunology</td>
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<td>natural resource recreation</td>
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<td>naval science</td>
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<td>nutritional sciences</td>
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<td>obstetrics and gynecology</td>
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<td>ophthalmology</td>
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<td>opti.</td>
<td>optical sciences</td>
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<td>Or.s.</td>
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<td>o.s.h.</td>
<td>occupational safety and health</td>
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<td>plant pathology</td>
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<td>pl.s.</td>
<td>plant sciences</td>
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<td>Portuguese</td>
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<td>range management</td>
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<td>wildlife and fisheries science</td>
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<td>water resources administration</td>
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<td>women's studies</td>
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<td>watershed management</td>
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### Graduate Calendar

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- **Last day to file Master's Degree Study Program for completion in December:** Jan. 10, W
- **Last day to file Doctoral Degree Study Program for completion in May 1990:** Jan. 14, Th
- **Last day to file Report on Master's Final Examination and thesis:** Jan. 16, Tu
- **Last day of classes and final examination day:** Jan. 19, Th
- **First Summer Session:**
  - Classes begin June 4, M
  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W
  - Last day to submit Report on Master's Final Examination and thesis:** May 27, W

#### Second Semester

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<th>1989-90</th>
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<td>Jan. 10, W</td>
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</table>

- **Last day to register for credit, to add courses, and to change from no credit to credit:** Jan. 16, W
- **Last day to drop courses and to change from credit to no credit:** Jan. 16, W
- **Last day to take doctoral final oral examination:** Jan. 16, W
- **Last day to drop with deletion of course from record:** Jan. 16, W
- **Last day to pay fees for master's and specialist degree candidacy and dissertation processing:** Jan. 16, W
- **Last day to file Report on Master's Final Examination and thesis:** May 27, W
- **Last day of classes and final examination day:** July 4, W

### Notes

- **First Summer Session**
  - Classes begin June 4, M
  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W

- **Second Summer Session**
  - Classes begin July 9, M
  - Last day to submit Report on Master's Final Examination and thesis:** July 24, W
  - Last day of classes and final examination day:** July 25, W

- **First Summer Session**
  - Classes begin June 4, M
  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W

- **Second Summer Session**
  - Classes begin July 9, M
  - Last day to submit Report on Master's Final Examination and thesis:** July 24, W
  - Last day of classes and final examination day:** July 25, W

- **First Summer Session**
  - Classes begin June 4, M
  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W

- **Second Summer Session**
  - Classes begin July 9, M
  - Last day to submit Report on Master's Final Examination and thesis:** July 24, W
  - Last day of classes and final examination day:** July 25, W

- **First Summer Session**
  - Classes begin June 4, M
  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W

- **Second Summer Session**
  - Classes begin July 9, M
  - Last day to submit Report on Master's Final Examination and thesis:** July 24, W
  - Last day of classes and final examination day:** July 25, W

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  - Holiday—No classes June 10, Su
  - Last day of classes and final examination day July 4, W

- **Second Summer Session**
  - Classes begin July 9, M
  - Last day to submit Report on Master's Final Examination and thesis:** July 24, W
  - Last day of classes and final examination day:** July 25, W
Arizona Board of Regents

Ex Officio

Rose Mofford, Governor of Arizona
C. Diane Bishop, State Superintendent of Public Instruction

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Patrick McWhortor, Assistant Treasurer, May, 1989
Donald G. Shropshire, Acting Dean, College of Agriculture, January, 1990
A. Jack Pflister, LL.B., January, 1990
Edith S. Austlander, Ph.D., January, 1990
President Elect, Herman Chenen, President, January, 1992
Dondale Pitt, J.D., Secretary, January, 1994
Esther N. Capin, M.Ed., Treasurer, January, 1994
Andrew D. Hurwitz, Treasurer, January, 1996
Douglas J. Wall, Treasurer, January, 1996

University Administration

Administrative Officers

Year of first University appointment in parentheses after each name

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Jack R. Cole (1957), Acting Provost
Ben Tuchi (1985), Senior Vice President for Administration and Finance
Allan Beigel (1970), Vice President for University Relations and Development
Sarah A. Blake (1983), Vice President for Planning and Budgeting
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Dudley R. Ecker (1953), Vice President for Student Affairs
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George H. Davis (1970), Vice Provost for Academic Affairs
Albert B. Weaver (1958), Executive Vice President Emeritus
Richard M. Edwards (1959), Vice President Emeritus for Student Relations
Arno Richard Kassander (1954), Vice President Emeritus for Research
Shepherd C. Cale (1954), Treasurer and Contracting Officer Emeritus

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Adela A. Allen (1968), Associate Dean of the Graduate College

Deans

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Donald J. Irving (1982), Dean of the Faculty of Fine Arts, College of Arts and Sciences
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Lee Sigelman (1987), Dean, Faculty of Social and Behavioral Sciences
Ernest T. Smorton (1988), Dean, College of Engineering and Mines
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David L. Windsor (1945), Dean Emeritus of Admissions and Records

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Barry Garapal, Professor of Nuclear and Energy Engineering
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Michael Mayerson, Professor of Pharmaceutical Sciences
Virginia Richardson, Associate Professor of Teaching and Teacher Education
Suzan M. Stearns, Professor of Linguistics
Spencer R. Talley, Professor of Geosciences
Ellis Vasquez, Professor of Anthropology
Melanie Weidtorf, Professor of Marketing
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Mary C. Wetzel, Professor of Psychology
Marta Yoshimura, Student Member

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Jennifer D. Hall, Professor of Molecular and Cellular Biology
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Michael Mayerson, Professor of Pharmaceutical Sciences
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Adamowicz, Zdzislaw, Assistant Professor of Chemistry
Adams, William G., Associate Professor of Art
Adams, Hugh D., Assistant Professor of English
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Akin, Susan, Associate Professor of English
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Albers, David S., Professor of Pharmacology and of Internal Medicine
Alcorn, Stanley, Professor of Plant Pathology
Aleamoni, Lawrence M., Professor of Educational Psychology
Alepa, F. Paul, Professor of Internal Medicine
Alexander, Mary A., Assistant Professor of Nursing
Allen, Adele, Associate Professor of Language, Reading and Culture
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Allen, R. Van, Professor Emeritus of Elementary Education
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Allred, Faye C., Professor of English
Allred, Ruth A., Professor Emeritus of Home Economics
Allman, Ellen, Professor of Library Science
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Alv, Eskander, Professor of Economics
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Ampel, Neil M., Assistant Professor of Internal Medicine
Amy, Gary, Associate Professor of Civil Engineering and Engineering Mechanics
Anders, Patricia L., Associate Professor of Language, Reading and Culture
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Anderson, Karen S., Associate Professor of History
Anderson, Robert M., Associate Professor Emeritus of Surgery
Anderson, Roger A., Professor Emeritus of Aerospace and Mechanical Engineering
Anderson, Waldo K., Professor Emeritus of Higher Education
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Betancourt, Eric, Professor of Atmospheric Physics, and in the Institute of Atmospheric Sciences

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Bernstein, Gary L., Professor of History
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Hamroff, Stuart R., Associate Professor of Anesthesiology
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Hamilton, Keith C., Professor of Plant Sciences
Hammond, Michael, Assistant Professor of Linguistics
Hancock, Jory L., Associate Professor of Dance
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Heckman, Steven K., Professor of Music
Heckel, Charles H., Associate Professor of Oriental Studies
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Hinton, Harwood, Professor of History
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Hirst, Edmund L., Associate Professor of Music
Hiskel, Brent, Professor of Materials Science and Engineering
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Hixson, Thomas J., Professor of Speech and Hearing Sciences
Hodges, Barton L., Professor of Ophthalmology
Hodgson, William R., Professor of Speech and Hearing Sciences and of Surgery
Hoehn, Susan A., Professor of Electrical and Computer Engineering
Hoff, Reza A., Professor of Law and of Economics
Hoffman, James J., Professor of Anesthesiology
Hoffman, Joseph J., Professor of Arid Land Sciences; Assistant Professor of Pharmaceutical Sciences
Hoffman, William F., Professor of Astronomy
Hoffich, Harold J., Professor Emeritus of Finance, Insurance and Real Estate
Hofmann, Wallace C., Associate Professor of Plant Sciences
Hogan, Craig J., Assistant Professor of Astronomy and of Astrophysics
Hogan, LeMoyne, Professor Emeritus of Plant Sciences
Hogle, Jerold E., Associate Professor of English
Hohmann, George W., Professor Emeritus of Psychology
Holm, Thomas M., Associate Professor of Political Science
Horka, Virginia M., Assistant Professor of Teaching and Teacher Education
Horka, William J., Associate Professor of Teaching and Teacher Education
Horstew, Robert, Professor of Ecology and Evolutionary Biology
Hosley, Richard, Professor Emeritus of English
Hou, John, Assistant Professor of Oriental Studies
Houston, Robert W., Professor of English
Howard, Alan J., Assistant Professor of Plant Pathology
Hoyer, Patricia B., Associate Professor of Physiology
Hubaj, Victor J., Professor of Chemistry and in the Arizona Research Laboratories
Hsieh, Siu-Ming, Professor of Psychology
Hsia, Kung, Associate Professor of Physiology
Hubbard, Stephen, Professor Emeritus of Biocatalysis and in the Lunar and Planetary Laboratory
Huber, John T., Professor of Animal Sciences
Huber, Roger T., Professor of Entomology
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Hudon, Scott, Associate Professor of Computer Science
Huey, Lawrence, Professor of Electrical and Computer Engineering
Huey, Alfredo R., Assistant Professor of Soil and Water Science
Hull, Donald R., Professor of Physics
Hughes, Malcolm K., Professor of Denichronology
Hult, Robert L., Professor Emeritus of Water Sheds Management
Hunt, Richard, Professor Emeritus of Music
Hunter, Glenn, Associate Professor of Surgery
Hunter, Tim B., Professor of Radiology
Hurli, Charlie D., Associate Professor of Library Science
Hutchinson, Charles F., Associate Professor of And Idaho
Hutcheson, Norman C., Assistant Professor of Computer Science
Hutter, John J., Jr., Associate Professor of Pediatrics
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Iacono, Timothy B., Assistant Professor of Surgery
Iacinto, D., Professor of Radiology and of Water Resources and of Civil Engineering and Environmental Mechanics
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Jacob, William O., Professor Emeritus of Agricultural Education
Jacobs, Stephen F., Professor of Optical Sciences
Jang, Jee-Won, Associate Professor of Dance in the School of Music
Jankowski, Richard, Associate Professor of Political Science
Janssen, Robert J., Associate Professor of Microbiology and Immunology
Jaworski, Bernard J., Associate Professor of Marketing
Jelinek, Arthur J., Professor of Anthropology
Jenks, Edgerton, Associate Professor of Surgery
Jensen, Gary F., Professor of Sociology
Jensen, Henning, Professor of Philosophy
Jensen, Marilyn, Associate Professor of Special Education and Rehabilitation
Jenness, Merle H., Professor of Plant Sciences
Jensfelt, Richard C., Associate Professor of Classics
Jensfelt, Richard G., Professor of Biochemistry and of Plant Sciences
Jeter, Wayne B., Professor Emeritus of Pharmacology and Toxicology and of Microbiology and Immunology
Jimenez, Rafael A., Professor of Art
Jimenez, Rudolf A., Professor of Civil Engineering and Engineering Mechanics
Jochums, Richard, Associate Professor of Physical Education and Athletics
Jocobs, W. C., Associate Professor of Family and Community Medicine
Joens, Lynn A., Associate Professor of Veterinary Science
Johnson, Bob G., Professor of Special Education and Rehabilitation
Johnson, David G., Professor of Pharmacology and of Internal Medicine
Johnson, Donna M, Assistant Professor of English
Johnson, Harry P., Professor Emeritus of Music
Johnson, Jack D., Professor of Arid Lands
Johnson, James W, Associate Professor of Journalism
Marcellin, Michael W., Assistant Professor of Electrical and Computer Engineering

Martin, John W., Professor of Spanish and Portuguese

Martin, Paul S., Professor of Geosciences

Martin, S. Clark, Professor Emeritus of Range Management

Martin, William E., Professor of Agricultural Economics

Martinez, Oscar, Professor of History

Martinez, Robert, Associate Professor of Electrical and Computer Engineering

Marten, H. James, Associate Professor of Geotechnology

Marten, Roy E, Professor of Management Information Systems

Marsian, Sally, Assistant Professor of Geography and Regional Development

Martin, A. Robert, Professor of Medicinal Chemistry

Martin, Holis K., Associate Professor Emeritus of Management

Martin, John W., Professor of Spanish and Portuguese

Marshall, John A., Associate Professor of Animal Sciences and of Nutrition and Food Science

Marshall, John B., Professor of Internal Medicine

Marcoux, Paul, Professor of Law

Mare, C. John, Professor of Veterinary Science

Marfia, John T., Professor of Anatomy

Marion, Mary H., Associate Professor of Family and Consumer Resources

Maroney, Peter R., Professor Emeritus of Drama

Marsh, Ozan, Professor of Music

Marshall, Robert H., Professor of Economics

Martin, Mark, Professor of Civil Engineering

Martens, John E., Professor of Psychology

Martz, Robert, Associate Professor of Medical Arts

Maryott, James, Professor of Geosciences

Marx, Francis, Professor of Engineering

Mason, Charles T., Professor of Ecology and Evolutionary Biology

Mason, Katherine A., Professor Emeritus of Nursing

Mathieu, Deborah R., Assistant Professor of Political Science and of Philosophy

Matlin, Joel D., Professor of Speech and Hearing Sciences and of Surgery

Matlock, William G., Professor Emeritus of Medical Sciences and of Surgery

May, Kathleen M., Associate Professor of Nursing

May, Warren L., Professor of Mathematics

Mayersohn, Michael, Professor of Pharmacy

McAlpin, Jay E., Associate Professor of Mathematics and of Molecular and Cellular Biology

McBride, James H., Associate Professor of Biology

McCaughey, William F., Professor Emeritus of Engineering

McCaughey, William F., Professor of Nutrition and Food Science

McCaulley, William J., Professor Emeritus of General Biology

McClellan, J. Brian, Assistant Professor of Range Management

McClellan, William L., Professor of Materials Science and Engineering

McClelland, Ted, Professor of Physical Education

McClellan, William J., Professor Emeritus of Chemical Engineering

McClelland, William J., Professor Emeritus of Physical Education

McClellan, William J., Professor Emeritus of Surgical Sciences

McClellan, William J., Professor Emeritus of Medical Sciences

McClellan, William J., Professor Emeritus of Surgery

McClellan, William J., Professor Emeritus of Internal Medicine

McClure, Margaret, Professor Emeritus of Nursing

McCullough, Edgar J., Jr., Professor of Geosciences

McCuskey, Robert S., Professor of Anatomy

McCuskey, Robert S., Professor of Anatomy

McDaniel, Robert G., Professor of Plant Sciences

McElroy, Donald M., Professor Emeritus of Aerospace and Mechanical Engineering

McElroy, D. Keith, Associate Professor of Art

McElroy, John H., Professor of English

McGee, Daniel L., Associate Professor of Radiation Oncology

McGee, Vann, Assistant Professor of Philosophy

McGinnis, William C., Professor Emeritus of Philosophy

McGill, Lyle H., Professor Emeritus of Accounting

McIntyre, Kenneth E., Professor of Surgery

McKee, W. David, Professor Emeritus of Medicine

McKee, Douglas H., Associate Professor of Pathology

McLaughlin, Calcutt M., Associate Professor of Music

McLaughlin, Douglas W., Professor of Mathematics

McMichael, Stephen P., Professor of Anesthesiology

McMichael, Robert W., Professor Emeritus of Art

McMillan, Terry L., Assistant Professor of English

McNamara, Donald J., Professor of Nutrition and Food Science

McNiece, Gerald M., Professor of English

McPheron, E. Gregory, Associate Professor of Landscape Architecture

McPhee, Albert R., Professor Emeritus of General Biology

McMurry, Marcello, Jr., Assistant Professor of Educational Foundations and Administration

Medline, Peter E., Associate Professor of English

McFerrin, Richard L., Professor of Architecture

Meinel, Aiden B., Professor Emeritus of Optical Sciences and of Astronomy

Meinke, William J., Professor of Microbiology and Immunology

Meinlin, Hayako, Professor of Surgery

Melzer, Robert S., Associate Professor of Ecology and Evolutionary Biology

Meltzer, Michael A., Associate Professor of Language, Reading and Culture

Melton, Henry J., IV, Professor of Planetary Sciences, of Geosciences and in the Lunar and Planetary Laboratory

Meltzer, Paul S., Assistant Professor of Pediatrics

Mendelson, Neil, Professor of Molecular and Cellular Biology

Mendez, Miguel M., Professor of Spanish and Portuguese

Mercado, Rodney M., Associate Professor of Music

Merrill, John V., Professor of History

Merritt, Curtis B., Professor of Educational Psychology

Metcalf, Darrel S., Professor Emeritus of Agronomy

Meyer, Michael C., Professor of History

Meystre, Pierre, Professor of Optical Sciences

Miao, Ronald C., Associate Professor of Oriental Studies

Michaud, Richard E., Professor of Ecology and Evolutionary Biology

Miele, Roger L., Assistant Professor of Biochemistry and of Molecular and Cellular Biology

Mikos, Haaren A., Professor Emeritus of Civil Engineering and Engineering Mechanics

Miller, Alvin E., Professor Emeritus of Architecture

Miller, Donna M., Professor of Exercise and Sport Science

Miller, Glen M., Assistant Professor of Agricultural Education

Miller, Jane R., Associate Professor of English

Miller, Jerry L., Associate Professor of Sociology

Miller, Thomas P., Professor Emeritus of Internal Medicine

Miller, Thomas P., Assistant Professor of English

Miller, Virginia J., Associate Professor Emerita of Nursing

Miller, Walter B., Professor Emeritus of General Biology

Miller, William B, Assistant Professor of Plant Sciences

Mills, John A., Associate Professor of English

Mills, Ronald D., Professor of Philosophy

Minta, Nancie, Professor of Management and Policy

Misagh, Nasim, Associate Professor of Plant Pathology

Mittle, Barrie, Professor of Nursing

Mishra, Shitala P, Professor of Educational Psychology

Mitchell, Jack N, Associate Professor of Language, Reading and Culture

Molt, Luis C., Associate Professor of Language, Reading and Culture

Molnar, Linda D., Professor of Sociology

Momaday, Navarre S., Professor of English

Monks, Eric A., Associate Professor of Agricultural Economics

Monsman, Gerald Professor of English

Monteith, Lesley K., Assistant Professor of Nuclear and Energy Engineering

Monty, Dewey E., Professor of Veterinary Science

Moore, John W., Jr., Assistant Professor of Plant Sciences
Moore, Greg C., Assistant Professor of Civil Engineering
Moore, J. Donald, Assistant Professor of Mechanical and Aerospace Engineering
Moore, Mary, Assistant Professor of History
Moore, Robert L., Professor of Computer Science
Moore, C. Peter, Assistant Professor of Philosophy
Moore, William J., Professor Emeritus of Chemistry
Moore, William E., Professor of Chemistry
Morley, E. J., Professor of Physics
Morrill, Calvin K., Assistant Professor of Communication
Morrison, Joan, Professor Emeritus of Psychology
Morris, J., Professor Emeritus of Electrical and Computer Engineering
Morrison, Une, Professor Emerita of Public Administration
Morse, Bart J., Associate Professor of Art
Morse, Richard L., Professor of Nuclear and Energy Engineering and of Physics
Müller, Elizabeth Kraus, Professor of Music
Mount, David W., Professor of Molecular and Cellular Biology, of Immunology and of Microbiology
Moss, Reza, Associate Professor of Molecular and Cellular Biology
Moss, Robert, Associate Professor of Molecular and Cellular Biology
Mudd, Carolyn L., Professor of Nursing
Mudd, Daniel L., Professor Emeritus of Metallurgical Engineering
Murphy, Edward W., Professor of Chemical Engineering
Murphy, Donald E., Professor of Mathematics
Murphy, Eugene W., Professor Emeritus of Computer Science
Murphy, Harold E., Professor of Soil Science
Nabben, Michael, Associate Professor of Exercise and Sport Sciences
Nam, Ilchong, Assistant Professor of Economics
Nagy, Bartholomew S., Professor of Geosciences
Nadel, Lynn, Professor of Psychology
Nagle, Raymond B., Professor of Pathology
Nagy, Barbara, Professor of Geosciences
Nakamoto, Kent, Assistant Professor of Marketing
Nam, Ichong, Assistant Professor of Economics
Nantel, Judith A., Associate Professor of Spanish and Portuguese
Narayan, Ramesh, Associate Professor of Astronomy and in the Arizona Research Laboratories
Nash, Pat N., Professor Emeritus of Elementary Education
Nasser, Kam, Associate Professor of Health Education
Nathanson, Tenney, Assistant Professor of English
Nathan, David S., Professor Emeritus of Management
Nett, Richmond C., Professor Emeritus of Civil Engineering and Engineering Mechanics
Nevins, Robert L., Associate Professor of Accounting
Netson, Aaron G., Professor Emeritus of Agricultural Economics
Netson, Tetia, Professor of Spanish and Portuguese
Netson, David L., Associate Professor of Pharmacology and Toxicology and of Psychiatry
Newcomb, Richard T., Associate Professor of Naval Science
Newcomb, Ronald, Associate Professor of Civil Engineering and Engineering Mechanics
Newell, Robert, Professor of Anthropology
Newman, Charles, Professor of Mathematics
Newman, John W., Professor of Marketing
Nichols, Andrew W., Professor of Family and Community Medicine
Nichols, Roger L., Professor of History
Nicolson, L., Professor of Educational Psychology
Nie, Mark A., Associate Professor of Anthropology
Nielson, Douglas A., Associate Professor of Dance
Nikravesh, F. E., Associate Professor of Aerospace and Mechanical Engineering
Nils, Marcia S., Professor Emeritus of Accounting
Nisaka, K., Professor of Mechanical Aerospace Studies
Noboy, A. E., Professor of Agricultural Engineering
Northcraft, Gregory B., Associate Professor of Management and Policy
Norton, Daniel J., Professor of Geosciences
Nowatzki, Edward A., Associate Professor of Civil Engineering and Engineering Mechanics
Nye, Alice L., Associate Professor of Nursing
Nugent, Charles A., Professor of Internal Medicine
Olmstead, Julia F., Professor of Management Information Systems and of Computer Science
O'Toole, William L., Professor Emeritus of Entomology
O'Connor, Patricia, Professor of Drama
O'Donnell, Patrick, Professor of English
Oehrle, Richard, Professor of Linguistics
O'Keeffe, James E., Professor of Anthropology
Ogren, David A., Professor of Internal Medicine
Ogden, Phyllis, Professor of Management
O'Hanlon, John F., Associate Professor of Electrical and Computer Engineering
Oishi, Karen, Assistant Professor of Molecular and Cellular Biology and of Plant Sciences
O'Leary, James W., Professor of Molecular and Cellular Biology
Olson, C., Professor Emeritus of Management
Olson, William J., Professor Emeritus of Accounting
O'Leary, James W., Professor of Molecular and Cellular Biology
Olsen, John W., Associate Professor of Anthropology
Olsen, Stanley J., Professor of Anthropology
Olsen, George P., Professor of Microbiology and Immunology and of Veterinary Science
Olsen, Kenneth S., Professor of Agricultural Education
Olsen, Walter L., Professor Emeritus of Special Education
O'Neil, Daniel J., Professor of Political Science
Oren, Steven L., Professor of English
Ortega, Alfonso, Assistant Professor of Aerospace and Mechanical Engineering
Ortiz, Keith, Assistant Professor of Aerospace and Mechanical Engineering
Ostlund, Lyman E., Professor of Marketing
Oswald, J. Gregory, Professor of History
Ott, Charles W., Associate Professor Emeritus of Physical Education
Otto, Charles W., Professor of Anesthesiology, of Radiology and of Surgery
Ough, Marguerite E., Professor Emerita of Music
Owens, Therese, Professor of Linguistics
Pacholczyk, Andrzej G., Associate Professor of Astronomy
Palmer, John D., Professor of Pharmacology, Assistant Professor of Internal Medicine
Palmer, John N., Associate Professor of Mathematics
Pakulska, Olga, Associate Professor of Electrical and Computer Engineering
Patilk, David A., Assistant Professor of Plant Sciences
Papadopoulos, Samuel H., Professor of Pathology
Park, Douglas L., Professor of Nutrition and Food Science
Park, Thomas W., Associate Professor Emeritus of History
Park, Edwin K., Professor Emeritus of Aerospace and Mechanical Engineering
Parmelee, J., Professor of Physics and in the General Division of the Arizona Research Laboratories
Parish, Gordon A., Associate Professor of Geosciences
Parry, Edward C., III, Professor of Art
Parsons, L., Professor of Nursing and Associate Professor of Physical Education
Patchett, P. Jonathan, Associate Professor of Geosciences and in the Crustal Genesis Division of the Arizona Research Laboratories
Pats, Glenn S., Associate Professor of Teaching and Teacher Education
Patrasciou, Adrian N., Professor of Physics
Patten, Jim D., Associate Professor of Journalism
Patterson, Gary K., Professor of Chemical Engineering
Peterson, Robert E., Professor of Electrical and Computer Engineering
Peterson, Dennis D., Professor of Radiology and of Optical Sciences
Peveril, Alice S., Associate Professor of Elementary Education
Pauflsen, R. Robert, Professor Emeritus of Higher Education
Pearland, Leonard A., Professor of Music
Pearlstein, Anne J., Assistant Professor of Aerospace and Mechanical Engineering
Pearson, Jack, Professor of Obstetrics and Gynecology
Peters, Ronald L., Professor of Geography and Regional Development
Petit, Leonard F., Professor of Surgery
Pemberton, Jeanne E., Associate Professor of Chemistry
Peterson, Jonathan D., Associate Professor of English
Pepper, Ian L., Associate Professor of Soil and Water Science
Perches, Ana, Assistant Professor of Spanish and Portuguese
Perry, Edward C., Associate Professor of Surgery and of Physical Education and Athletics
Perry, Garnett D., Professor Emeritus of Classics
Perin, Jessica V., Associate Professor of Nursing
Perkins, Henry C., Professor of Aerospace and Mechanical Engineering
Perkins, Catherine M., Associate Professor of Pathology
Peters, William C., Professor Emeritus of Military Science
Petersen, Eskild A., Associate Professor of Internal Medicine
Petersen, Margaret S., Associate Professor of Civil Engineering and Engineering Mechanics
Petersen, Robert A., Assistant Professor of Aerospace and Mechanical Engineering
Petersen, Russell E., Professor of Aerospace and Mechanical Engineering
Petersen, Gerald R., Professor of Electrical and Computer Engineering
Petersen, John C., Assistant Professor of Computer Science
Peterson, Larry L., Assistant Professor of Computer Science
Peterson, Mary A., Associate Professor of Psychology
Peterson, Thomas W., Associate Professor of Chemical Engineering
Phayghanian, Nasser, Associate Professor of Optimal Sciences
Phillips, John S., Associate Professor Emeritus of Mechanical Engineering
Phillips, Anthony F., Professor of Pediatrics
Phillips, Susan L., Professor of Anthropology
Phillips, Delbert D., Associate Professor of Russian and Slavic Languages
Phillips, Linda R., Assistant Professor of Nursing
Phillips, Robert A., Professor of Civil Engineering and Engineering Mechanics
Pickels, Frank P., Associate Professor of English
Piccioni, Albert L., Professor Emeritus of Pharmacology and Toxicology
Pielke, Peter E., Professor of Molecular and Cellular Biology
Pikrdlk, Doug, Assistant Professor of Mathematics
Pierce, Richard S., Professor of Mathematics
Pilgrim, Mary, Professor Emerita of Physical Education
Ping, David E., Associate Professor of Economics
Pinhas, Jacob L., Associate Professor of Internal Medicine
Pitt, Michael J., Professor of Radiology and of Surgery
Pitt, David A., Associate Professor of Geography and Regional Development
Pitt, Patricia M., Assistant Professor of Pharmacy Practice
Pogrow, Stanley, Associate Professor of Educational Foundations and Administration
Poirier, David, Professor of Materials Science and Engineering
Potash, Andy W., Assistant Professor of Art
Pollack, Paul F., Assistant Professor of Pediatrics
Polt, Robert E., Assistant Professor of Anatomy
Potter, Robin L., Associate Professor of Chemistry
Pond, Gerald D., Associate Professor of Radiology
Pond, Ronald A., Assistant Professor of Psychology
Poreca, Frank, Assistant Professor of Pharmacology
Post, Donald F., Professor of Soil and Water Science
Potter, L., Professor Emeritus of Nuclear and Energy Engineering
Potter, Harold L., Assistant Professor of Medical Technology
Powen, Charles E., Professor of English
Powell, Lawrence C., Professor Emeritus in Residence
Wright, Stephen H., Associate Professor of Physiology
Wyant, James C., Professor of Optical Sciences
Wygnanski, Israel J., Professor of Aerospace and Mechanical Engineering
Wymore, A. Wayne, Professor Emeritus of Systems and Industrial Engineering
Wyant, Ruth E., Assistant Professor Emerita of Exercise and Sport Sciences
Yakowitz, Sidney J., Professor of Systems and Industrial Engineering
Yalkowsky, Samuel H., Professor of Pharmaceutical Sciences
Yall, Irving, Professor Emeritus of Microbiology
Yamamura, Henry J., Professor of Biochemistry, of Pharmacology and in the Arizona Research Laboratories; Associate Professor of Psychiatry
Yappel, A. Ralph, Professor Emeritus of Aerospace and Mechanical Engineering
Yates, Alayne, Professor of Psychiatry; Associate Professor of Pediatrics
Yeh, Tian-Chyi J., Assistant Professor of Hydrology and Water Resources
Yin, Yong-Quan, Assistant Professor of Mathematics
Yiayew, Muluneh, Assistant Professor of Agricultural Engineering
Yocum, David E., Assistant Professor of Internal Medicine
Yoffee, Norman, Professor of Anthropology
Yoshino, T. Roger, Professor Emeritus of Sociology
Yost, Elizabeth B., Associate Professor of Psychology
Young, Robert L., Assistant Professor of Military Aerospace Studies
Young, Kenneth C., Associate Professor of Atmospheric Sciences and in the Institute of Atmospheric Physics
Young, Lai-Sang, Associate Professor of Mathematics
Younggren, Newell A., Professor Emeritus of Ecology and Evolutionary Biology
Zagona, Salvatore V., Professor Emeritus of Psychology
Zajac, Edward E., Professor of Economics
Zapotocky, Joseph A., Professor Emeritus of Pharmaceutical Sciences
Zegura, Stephen L., Associate Professor of Anthropology
Zehnder, Joseph A., Assistant Professor of Atmospheric Physics and of Atmospheric Sciences
Zeigler, Bernard P., Professor of Electrical and Computer Engineering
Zelinski, Brian J.J., Assistant Professor of Materials Science and Engineering
Zepreta, Oleta, Assistant Professor of Linguistics
Zube, Ervin H., Professor of Renewable Natural Resources
Zukowski, Charles F., Professor of Surgery
Zumbro, Nicholas, Professor of Music
Zurbrick, Philip R. Professor of Agricultural Education
Zwingel, Lynda M., Assistant Professor of English
Zwolinski, Malcolm J., Professor of Watershed Management
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. Research is also conducted on farms, orchards, ranches, rangelands, and forests in cooperation with farmers, ranchers, and officials of various state and federal agencies.

Arizona Center for Educational Evaluation and Measurement (1980) initiates and conducts multidisciplinary research on such topics as nondiscriminatory psychological assessment; assessment of developmental competencies, sequencing of instruction, cognitive skills in children; and evaluation of school effectiveness. The center maintains state-of-the-art
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 Study Unit (1973), located in the School of Renewable Natural Resources, is engaged in research to support the natural science program of the National Park Service. In cooperation with the University of Arizona, the unit provides graduate research opportunities and instructional support in a broad array of natural resource problem areas.

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 (listened on the inside cover of Arizona telephone directories) and can be reached 24 hours a day, seven days a week. Full-time clinical pharmacists staff the center and serve as poison and drug information specialists. Serving as consultants are medical toxicologists and specialists in plant and animal poisons, drugs, and environmental and industrial poisons. The Arizona Poison and Drug Information Center also provides for clinical training of pharmacy students in the areas of drug and poison information. The Arizona Poison and Drug Information Center is a component of the Arizona Poison Control System which was established at the University of Arizona by the Arizona State Legislature in 1980. The Arizona Poison Control System is certified as a regional poison control program by the American Association of Poison Control Centers.

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

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

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

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

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

The Boyce Thompson Southwestern Arboretum (1927) is operated cooperatively by the University of Arizona (College of Agriculture), Arizona State Parks Board, and the Boyce Thompson Southwestern Arboretum Board. This public botanic garden has facilities for teaching and research. Situated on the edge of the low desert near Superior, Arizona, the arboretum is a two-hour drive from the campus. Thirty acres of native and introduced plants from arid and semi-arid regions, together with about 4,000 additional acres of undisturbed fauna and flora, are under arboretum control. Additionally, large tracts of relatively undisturbed habitats in a variety of biomes lie in the surrounding Tonto National Forest. Laboratory facilities and housing are available. The arboretum is open daily except for Christmas Day.

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

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

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

The Center for Computing and Information Technology (CCIT) provides campus-wide services and facilities in support of the instructional, research, and administrative computing needs of the University. The University's network of shared computers consists of a Control Data Corporation CYBER 175 computer, three VAX 11/780's, a VAX 11/750, a VAX 8700, and a VAX 8650 computer system in a cluster environment, an IBM 4381 and an IBM 3090 computer, one Prime computer system, and a Scientific Computer Systems (SCS-40) minicomputer. These computers are interconnected to allow data transfer between systems. The CCIT provides a campus-wide data communications network supporting both central and distributed processors. Access to facilities is available 24 hours a day. Additionally, CCIT provides access to outside networks such as Bitnet and NSF NET, and to other major national supercomputer networks. Connections are available to the national supercomputer centers at Princeton, Cornell, Pittsburgh, Illinois, San Diego and NCAR. The CCIT provides terminal access centers at various locations on campus and dial-up access to the university systems. The CCIT offers many services to assist users in taking advantage of available computing resources. Services include consulting on the use of the University's computers and various microcomputers; assistance in user acquisition of computing facilities; communications and networking between user-owned equipment and the University's systems; computer facility planning and preparation; selection, acquisition, and installation of microcomputer hardware and software; mainframe and microcomputer training facilities; programming and applications services; and dissemination of information through user publications, manuals, and program library documentation.

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

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

The Center for the Management of Information (CMI), the Center for the Management of Information, established through a grant from IBM, fosters programs designed to develop interdisciplinary approaches to the management of information. CMI activities have resulted in the development of a new integrated MBA curriculum that was implemented in the fall of 1986, and laboratories equipped with state-of-the-art technology 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 in various areas of science. Recent advances in the understanding of fundamental aspects of nonlinear systems, coupled with progress in computer technology, permit new approaches to heretofore intractable scientific problems, in diverse fields: climate; cognitive science; computational theory; elementary particle physics; evolutionary biology; materials and condensed matter science; motor control, robotics and prosthetics; neurobiology; vascular physiology; turbulence; and others. The center sponsors research, visiting scientists, workshops, and colloquia, all aimed at encouraging the development of new approaches to complexity at the interfaces between traditional scientific disciplines such as biology, chemistry, mathematics, and physics.

The Center for the Study of Higher Education (1978) in the College of Education conducts research studies and provides
related service activities to meet state and institutional needs, as well as those of national, international and regional governmental units and other organizations. It develops and disseminates information about higher education policy and 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 agricultural production and natural resources, family and consumer sciences, youth development (4-H), and community leadership and resource development. The service is financed from federal, state, and county appropriations. It operates through the county extension agent, state and area specialist system with faculty trained in their specialty, and in the practical application of scientific information on farms, ranches and rural and urban homes. Assistance is provided to target audiences in problem solving, information dissemination and educational programs.

The Division of Economic and Business Research (1949) is a research and service organization within the College of Business and Public Administration. Its broad objectives are to conduct research relating to business, economics, 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 semi-annual Arizona Review, the monthly Arizona's Economy, the chart book Arizona Economic Indicators, and the Arizona Statistical Abstract. It also produces forums and seminars for the public. In addition, DEBR answers requests from business, government, and the general public for tabular information and maps showing local demographic and business patterns and, as a member of the State Data Center, for computerized census information.

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

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 Translocator Frequency, 89.7 MHz in northwest Tucson and Sierra Vista and 105.5 in Phoenix). Professional production facilities are maintained in the Modern Languages Building, the Audiovisual Building and the Harrill 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 animals 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) for intensive food production, in seawater crop irrigation, and in solar heating and cooling. ERL has designed CEA vegetable systems which produce crops in the desert sands of the United
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 of Arizona by Grace H. Flandrau. The facility is located on the north side of the University Mall and houses a 50-foot projection dome and a 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 a 16-inch telescope are open free to the public. Open daily except Mondays.

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

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

The Karl Eller Center for the Study of the Private Market Economy (1983) is a research and education organization within the College of Business and Public Administration. It has three broad objectives: (1) to promote research 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-level instruction is offered through cooperating academic departments, and a limited number of graduate research assistantships are available to qualified students. Current research efforts are directed toward the quantification of tree-ring parameters, the establishment of new tree-ring chronologies throughout the world, the understanding of basic tree growth and environmental relationships, the reconstruction of paleohydrologic, paleoclimatic, and paleoecological variables, and the documentation and development of prehistoric chronological controls. Along with the world's largest collection of tree-ring specimens from living trees and ancient timbers, the laboratory maintains a variety of specialized equipment and data files containing processed tree-ring chronologies, relevant climatic and hydrologic records, and archaeological tree-ring dates and site information.

The Lunar and Planetary Laboratory (1960), the research institute associated with the Planetary Sciences Department, is housed in the George 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 microscope, 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, polariometry 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, through conferences, the historical 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...
Nuclear Reactor. The TRIGA reactor in the Department of Nuclear and Energy Engineering is both a training and a research facility. The uranium-zirconium hydride-fueled, pool-type reactor is conveniently designed for the study of many research problems in reactor engineering, including those of variation in core geometry, shielding, neutron behavior, transient characteristics, and control.

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

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

A pneumatic sample irradiation facility is available for research with short-lived radioactive materials, and external neutron beams may be used for neutron radiography. A variety of gamma ray spectroscopy equipment is available to allow full use of the activation analysis.

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

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

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

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

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

The Social and Behavioral Sciences Research Institute promotes fundamental and applied research focusing on both individuals and social groups. The areas of fundamental research encompass individual behavior, including its linguistic and neurobiological 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 pioneer Jewish history. Southwest Center initiatives are designed for their multiplier effects on the research and service mission of the University, creating new opportunities for interdisciplinary scholarship. As an agency dedicated to the enhancement of regional scholarship and intellectual service, the Southwest Center acts as a liaison to funding sources; creates and implements interdisciplinary regional research projects; pursues a vigorous publishing program; and engages in a broad range of public outreach and programming: conferences, seminars, lectures, speakers' bureau, cultural events. In partnership with the UA Press, the center publishes Journal of the Southwest, a scholarly regional quarterly, and sponsors the Southwest Center book series.
The Southwest Institute for Research on Women (SIROW) (1979) is a regional research and resource center within the Committee on Women's Studies. The institute develops and conducts research on women in the Southwest (Arizona, Colorado, New Mexico, and Utah) or of interest to scholars in the region. SIROW publishes a newsletter and a working paper series and 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. Biglow station in the Santa Catalina Mountains. The MMT, operated jointly with the Smithsonian Astrophysical Observatory, represents the most successful concept for construction of large optical telescopes; it has become the prototype for future large-aperture telescopes. 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 RadioAstronomy Observatory jointly sponsor a weekly series of professional colloquia. Steward Observatory also maintains close working ties with the Vatican Observatory, the Arizona Health Sciences Library, the Arizona State Museum Library, and the Arizona Health Sciences Library. Special Collections, and the Library Science Library. Four large but separate library facilities are the College of Law Library, the Architecture Library, the Herbarium, and the Lunar and Planetary Sciences Library. In addition, several other departmental libraries such as the Division of Humanities and Social Sciences Library, the Science-Engineering Library, and the Media Center have been established to serve special research needs.

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

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

Map Collection is a depository for USGS maps, and houses a fully cataloged collection of almost 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 360,000 volumes, over a million microforms, and displays current issues of its 4500-plus periodicals.

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

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

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

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

Oriental Studies Collection houses books, periodicals and newspapers in the Chinese, Japanese, Arabic, Persian, Hindi, Urdu, Turkish, and other Oriental languages; it has over 160,000 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 catalogued volumes and receives approximately 3100 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 catalogued 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 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 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.

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

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

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

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

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

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

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

Cooperating Organizations

Certain other independent agencies, not administratively a part of the University of Arizona, cooperate closely with the University and provide opportunity for study and research for faculty and qualified graduate students. Several of these are actually located on the University campus, and certain staff members of some also hold University staff appointments.

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

Arizona Historical Society. Organized in 1884 for "the collection and preservation of materials illustrative of the history of Arizona in particular and of the West generally," the Society receives support from the state, and maintains both a historical museum and a research library. The museum and library are located adjoining the University campus and contain 50,000 books, 2,000 manuscript collections, and 250,000 photographs. The manuscript-collections are especially rich, with letters, diaries, journals, business records and other documents, many of which are still partially or completely unpublished. One of its most valuable research resources is its file of over 3,000 bound volumes of Arizona newspapers beginning with the first issue of the first weekly in 1859. State and federal historical records are on microfilm, as are records from Spanish colonial archives. Membership is open to everyone.

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

The Southwestern Research Station of the American Museum of Natural History, New York, is located within a few hours of the University campus in the Chiricahua Mountains of southeastern Arizona. The station proper is located at an elevation of 5,400 feet in a moderate evergreen woodland climate, midway between the desert below and the coniferous forest above. A wide variety of life zones is represented within a few miles of the station between the desert floor and the fir-covered peaks at 9,800 feet. This unsplendid area within the Coronado National Forest includes many protected wilderness areas accessible only on foot or horseback. Station living facilities and equipment are available, and the laboratory is well equipped for many kinds of modern field and laboratory research in ecology and physiology. The station is a field base for almost any kind of field work in biology, geology, paleontology, resource management, and wildlife management.

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

**Fees—1989-1990**

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

### Legal Residents of Arizona:

- Payment at time of registration
- Residence halls, average rate**
- Meals in university cafeteria
- Books and supplies
- Total minimum annual expense

### Nonresidents of Arizona:

- Payment at time of registration
- Residence halls, average rate**
- Meals in university cafeteria
- Books and supplies
- Total minimum annual expense

### Miscellaneous Expenses

#### Application fees
- to graduate degree program
- to graduate nondegree status
- for readmission

#### Music fee for private lessons, per semester****
- 1/2 hr. per week
- 1 hr. per week

#### Late registration fee (any period)
- Foreign student language examination fee
- (any one examination)

#### Processing fee (thesis or dissertation)
- Dissertation microfilm fee
- Caps and gowns are purchased for $15.50 or $18.50, depending upon degree. Hoods are purchased for $14.50 or $17.00, depending upon degree.

### 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.
Student Services

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 $230.00.

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 Advisor; the American Indian Student Advisor; and the Veterans' office. For full information concerning each of these, the student should consult the Dean of Students Office or the General Catalog.
The Nature of Graduate Work

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

Admission

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

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

In general, degrees that are recognized should be based on a unit of credit comparable to that defined by the Arizona Board of Regents (26 May 1979) for institutions under its jurisdiction. A minimum of 45 hours of work by each student is required for each unit of credit. An hour of work is the equivalent of 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 consecutive 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 will be in good standing after completing nine credit hours of graduate work with superior grades, and subject to any additional requirements established by the major department or academic unit.

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 Foreign Students

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

International Special Status

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

Proficiency in English

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

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

Financial Resources for Foreign Students

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

Application for Admission

Application for admission to the Graduate College must be made on forms furnished by the Graduate College. Completed application forms must arrive before supporting transcripts come or processing can be seriously delayed. An applicant from another institution should request that one set of complete official transcripts of all undergraduate and graduate work done and degrees received be sent directly by the institution at which the work was done to the Dean of the Graduate College of the University of Arizona. Credits which appear as transfer credits on any other transcript are not valid; applicants must submit an official transcript from the school where the credits were earned. Both the application and the transcripts should be on file four to six months prior to registration. Applicants whose records are not in English are required to provide a certified translation of their records. Applicants should also contact the department of their intended major to obtain departmental application materials and requirements.

Students who have been admitted to the Graduate College but who were not enrolled during the previous regular semester must reapply for admission. (See "Admission for Part of an Academic Year" for exception to this policy.) All material becomes the property of the Graduate College and will not be returned.

Candidacy for an Advanced Degree

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

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

Graduate Credit for Seniors

A University of Arizona student of senior standing who is within 15 units of completing all requirements for graduation may register for graduate work if recommended by the head of the department and approved by the Dean of the Graduate College. For such registration a petition for graduate credit in excess of senior requirements must be filed with the Dean at the time of registration. This petition must be endorsed by the professor in charge of the course and the student's adviser. The Dean will not approve a petition unless the senior has a grade-point average of 3.00 or better on all work already completed at the University, is proceeding toward graduation as directly as possible, and does not propose a total load to exceed sixteen units. The maximum number of units of graduate credit that may be earned by a senior in any semester is equal to the difference between sixteen and the number necessary to complete requirements for graduation.

General Prerequisites for Major Graduate Credit

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

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

Regular Graduate Credit Courses

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

Use of 400-Level Courses in Graduate Programs

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

Transfer of Graduate Credit

The University of Arizona accepts graduate credit by transfer from other accredited institutions, however, the whole number of transferred units offered toward a master's degree may not exceed twenty percent of the minimum number of units required for the degree in question. Such transfer of credit may be applied toward an advanced degree only upon 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 Check Office, may be initiated at any time but will not become effective until the student has completed satisfactorily at least twelve units of graduate work at the University of Arizona. Credit for extension work from other institutions will not be accepted.

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
- **P** - Passing (see section on “Pass-Fail Option”)
- **F** - Failure (see section on “Pass-Fail Option”)
- **S** - Superior (see paragraph on “Special Grades”)
- **I** - Incomplete
- **K** - Course in progress
- **W** - Approved withdrawal
- **O** - Audit
- **CR** - Credit

**Examinations Required**

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 week. The grade of W shall not be awarded to students who are failing at the time of withdrawal. The grade of W shall not be awarded to students who are failing at the time of withdrawal.

**Special Grades**

The grades S (superior) or P (passing) are used in place of 908, 909, 910, 915, 920, and 925 are S, P, E, K, and W. The only grade available for 930 is K. Special grades (S, P) are not used in the computation of the grade point average.

**Averaging of Grades**

For the purpose of computing grade-point averages, grade points are assigned to each grade as follows: A, 4 points for each unit; B, 3 points; C, 2 points, D, 1 point; and E, 0 points. To calculate the grade point average, the unit value for each course in which a student receives one of the above grades is multiplied by the number of grade points for that grade. The sum of these products is then divided by the sum of the units of A, B, C, D, and E. The grade point average is based 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.

**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 still must register should enroll for supplementary registration (course number 930). Supplementary registration may be used concurrently with other enrollments to meet these registration requirements.

Thesis and Dissertation Work in Absentia

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

Auditing of Courses by Graduate Students

With the consent of the Dean of the Graduate College and the instructors concerned, students enrolled in the Graduate College may unofficially audit courses not included in their regular programs. It is not necessary to register for such courses, but an auditor's permit must be obtained from the Dean. If courses are audited officially by registering as an auditor, the units 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—Tuition per unit of credit for the 1989-90 academic year is $71.00. There is no additional nonresident fee for out-of-state students. In addition to the per unit tuition fee, students are assessed a student fee of $5.50 per unit. Since fees are subject to change, students should consult the current Summer Session Schedule of Classes for fees in effect for any given year.

Graduate Appointments, Scholarships and Financial Aids

Financial assistance for graduate students is available from diverse sources, but the primary source of information 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 $2,644 to $4,242 for services not exceeding ten hours a week, or $5,289 to $8,494 for half-time assistantships.

Tuition and Fees—Graduate assistants and associates are exempt from the nonresident tuition charge and from 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 Academic Scholarships, which waive the registration fee, are available in limited numbers for academically qualified graduate students. As with the Graduate Tuition Scholarships, recipients must be recommended by their major departments and approved by the Graduate College.

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

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

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

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

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

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

Loans

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

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

A separate application is required for the Guaranteed Student Loan Program. An applicant must be admitted to a degree program before submitting the application to the Office of Student Financial Aid. The total processing time at the University, bank and guaranty agency can take up to four months. Therefore, early application is advised.
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 economics
- agricultural education
- agricultural engineering
- agronomy & plant genetics
- American Indian studies
- anatomy*
- animal sciences
- anthropology
- applied mathematics
- architecture
- art
- art education
- art history
- astronomy
- atmospheric sciences
- bilingual/bicultural education
- biochemistry
- 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
- drama
- ecology & evolutionary biology
- economics
- educational administration
- educational media
- educational psychology
- electrical engineering
- elementary education
- engineering mechanics
- English
- English as a second language
- entomology
- exercise and sport sciences
- family and consumer resources
- finance
- food science
- foundations of education
- French
- general biology
- genetics
- geography
- geological engineering
- geosciences
- German
- health education
- higher education
- history
- home economics education
- horticulture
- hydrology
- industrial engineering
- journalism
- landscape architecture
- Latin American studies
- library science
- linguistics
- management and policy
- management information systems
- marketing
- materials science & engineering
- mathematics
- mechanical engineering
- microbiology & immunology
- mineral economics
- mining engineering
- molecular & cellular biology
- music education
- music theory
- musicology
- neuroscience
- nuclear engineering
- nursing
- nutritional sciences
- optical sciences
- Oriental studies
- performance (music)
- pharmaceutical sciences
- pharmacology
- pharmacy
- philosophy
- physics
- physiological sciences*
- planetary sciences
- planning
- plant pathology
- plant protection
- political science
- poultry science
- psychology
- public administration
- range management
- reading
- rehabilitation
- reliability engineering
- renewable natural resources studies
- Russian
- secondary education
- sociology
- soil & water science
- Spanish
- special education
- speech & hearing sciences
- statistics
- systems engineering
- toxicology
- water resources
- administration
- watershed management
- wildlife and fisheries science

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

Major work leading to a specialist degree is offered in each of the following fields:
- educational administration
- educational media
- educational psychology
- elementary education
- microbiology
- nursing
- reading
- secondary education
- special education

Major Fields for Doctoral Degrees

Major work and research leading to a doctoral degree are offered in the following fields. (Except as noted, the degree is the Doctor of Philosophy.)
- agronomy & plant genetics
- anatomy
- applied mathematics
- arid lands resource sciences
- astronomy
- atmospheric sciences
- botany
- business administration
- 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
- ecology & evolutionary biology
- economics
- educational administration
- educational psychology
- electrical engineering
- elementary education
- engineering mechanics
- English
- English education
- family and consumer resources
- foundations of education
- French
- general biology
- genetics
- geography
- geological engineering
- geosciences
- higher education
- history
- horticulture
- hydrology
- irrigation engineering
- linguistics
- materials science & engineering
- mathematics
- mechanical engineering
- microbiology & immunology
- mineral economics
- mining engineering
- molecular & cellular biology
- music education
- music theory
- neuroscience
- nuclear engineering
- nursing
- nutritional sciences
- optical sciences
- Oriental studies
- performance (music/A.Mus.D.)
- pharmaceutical sciences
- pharmacology and toxicology
- pharmacy
- philosophy
- physics
- physiological sciences
- planetary sciences
- plant pathology
- political science
- psychology
- range management
- reading
- rehabilitation

*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 Arts in Teaching (M.A.T.)
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 Library Science (M.L.S.)
Master of Music (M.M.)
Master of Music (M.M.)
Master of Public Administration (M.P.A.)
Master of Science (M.S.)
Master of Science (M.S.)
Master of Teaching (M.T.)
Educational Specialist (Ed.S., Ed.D.)
Nursing Specialist (N.S.)
Specialist in Microbiology (Sp.M.)
Doctor of Education (Ed.D.)
Doctor of Education (Ed.D.)
Doctor of Musical Arts (A.Mus.D.)
Doctor of Philosophy (Ph.D.)

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

General Requirements

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

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

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

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

Master's Degree Study Program—See the Graduate Calendar for deadline dates by which the Master's Degree Study Program must be submitted to the Graduate College. This notice, approved by the major advisor and the department head 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.

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.
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. Under-
graduate courses in finite mathematics calculus are prerequisites and should be completed prior to entering the program. If the math deficiencies are not eliminated before beginning course work, students must enroll in M.I.S. 400 (a fast-paced finite math and calculus course) during the first semester.

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

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

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

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

First semester (Fall):      
Total units = 15.

Second semester (Spring):   

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

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

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

Master of Education

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

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

Other Approved Majors: chemistry, English, family and consumer resources, French, general biology, geography, German, health education, history, journalism, mathematics, Oriental studies, physics, political science, Russian, Spanish, and communication. Students with any of these majors will have an advisor in the College of Education as well as in the appropriate major department. Other majors may be approved on an individual basis by the Graduate Council when specifically requested by the College of Education and the proposed major department. Applicants must meet the admission 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 Office of Student Services in 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; Drama, and English offer programs leading to the Master of Fine Arts degree with majors in art, drama, and creative writing respectively. Applicants must have completed appropriate undergraduate majors at this institution or one of similar standing. Deficiencies may be established if the applicant's undergraduate major differs significantly from the corresponding major at the University of Arizona. Theses are not required but the departments reserve the right to retain for departmental collections a selected work, or works, from those submitted in connection with students' work toward a degree. Final examinations are required. Applicants should contact the appropriate department and ask for instructions about submitting examples of creative work directly to the department in support of an application. Special features and requirements of the three programs are described below.

Major in Art

Applicants must submit slides of their studio work (or in the case of the photography program applicants, original photographs) directly to the Department of Art. All other application materials, including transcripts, are to be sent to the Graduate College. No application will be considered until slides or photographs, transcripts, and application forms have been received. The requirements are the same as those for the degree of Master of Fine Arts with the following exceptions. The unit requirement for this program is sixty units, of which twelve must be in history of art and 48 in studio art courses. In lieu of a thesis, an original work, or group of such works, must be presented to the public. Review of this work will accompany the final oral examination. The exhibit may be accompanied by a written document, but the document itself will not be considered a thesis. As evidence of completion of this work, a folio of slides or photographs of the exhibition must be submitted to the Art Department graduate committee upon completion of the final examination. The candidate may be required to prepare a one-person exhibit of the work or to participate in a group exhibit during the last semester in residence.

Major in Creative Writing

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

The unit requirement for this program is sixty units. Concentrations are available in acting-directing, 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, 693, 4 units of 696b, 909, 6 additional units of theatre history, dramatic theory, or criticism, 3 units of Dnc. 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 531, 549, 551, 552, 556, 575, 4 units of 597, 600, 605, 606, 650, 655, 693, 3 units of 696b, 3 units of 696d, 909, 6 additional units of theatre history, dramatic theory, or criticism, and one unit of Dnc. 691. In lieu of a thesis, each student must present a monograph on the direction of a play, presented and prepared according to departmental guidelines.

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

Dramatic Writing Option: Program requirements are Dram. 560a-560b, 600, 640, 641, 642a-642b, 644, 9 units of 696, 909, 12 units of drama production including acting, directing, design, and technical theatre, and 12 units from an area of concentration outside of the department such as creative writing, English literature, or media arts. In lieu of a thesis, each student must present a master's project play, presented and prepared according to departmental guidelines.

Master of Landscape Architecture

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

Applicants should send a two-page statement indicating their goals and 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. This degree qualifies graduates for professional positions in all fields of librarianship including academic, public, and special libraries. To be qualified for school libraries, specified education courses are required for certification. See also the headnotes under Library Science elsewhere in this catalog. The Graduate Library School is accredited by the American Library Association.

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

The program requires completion of 38 graduate units including Li.S. 502, 503, 504, 505, 506, 510, 582, and 507 or 581. Students who have completed courses similar to these at other institutions may have these courses waived as requirements. Written petition for waivers must be made to the Graduate Library School in the student's first semester in the program.

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

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

Master of Music

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

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

Major in Composition

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

Major in Musicology

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

Major in Music Education

Applicants for master's degree programs in music education must qualify for teacher certification prior to completion of the degree. Students may select a concentration in instrumental, choral, or general music or may participate in the design of a program suited to individual professional objectives. All programs require a minimum of 30 graduate units. No more than six units of credit in special workshops may be substituted for courses in music education. The degree culminates in a major project which demonstrates 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, and criminal justice and additional specializations are being developed. Students with excellent first year records may design individual specializations if warranted.

Finally, a 6-unit internship is required.

For admission consideration, applicants must submit a superior undergraduate record and an acceptable score on the Graduate Record Examination or the Graduate Management Admissions Test. Applicants must be competent in basic 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 Office of Student Services in the College of Education or the Division of Teaching and Teacher Education for information regarding the status and requirements of all programs and degrees.
REQUIREDMENTS FOR SPECIALIST DEGREES

Educational Specialist

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

Admission

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

Qualifying Examination

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

Time Limitations

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

Advisory Committee

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

Program of Study

A program of study, recommended by the division head and approved by the Office of Student Services in Education, shall be submitted promptly for the approval of the Graduate Council following successful completion of the qualifying examination. It is to be designed, in cooperation with the Advisory Council, to meet the needs of the individual student as determined by previous academic work, experience, interests, and career objectives. Please see the Office of Student Services in the College of Education or the appropriate division for information on program requirements.

Final Examination

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

Professional Experience

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

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

Admission

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

Program of Study

The program provides education and experience in a particular subspecialty area of nursing beyond the level normally attained in a master's degree program. The program is intensive and requires full-time attention to courses and associated seminars and practicums. Programs of study are individually planned in consultation with an advisor after consideration of previous academic work and experience, personal interests, and professional objectives. Two options are available: (1) An applicant with a bachelor's degree in nursing may enroll for 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.

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 institution will be asked to demonstrate acceptability during their first term in residence, either through an examination or careful evaluation of their performance in course work.

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

Specialist in Microbiology

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

Admission

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

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

Program of Study

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

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

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

Doctor of Philosophy

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

Residence and Credit Requirements

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

To meet the minimum residence requirement, the student must spend two regular semesters of essentially full-time 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 eighteen units of dissertation credit (920) is required during the conduct of the dissertation, with a maximum of nine units during any regular semester. With the prior approval of the student’s dissertation committee and the head of the academic unit, dissertation work may be done in absentia.

All requirements for the degree of Doctor of Philosophy, 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 should be submitted for approval by the Graduate Council on a form provided by the
Graduate College prior to the completion of half of the non-
dissertation units proposed. The program must conform to the
requirements set forth in this catalog and those issued from
time to time by the Graduate Council, including the general
requirement that the required units be offered in 500-level or
above, university-credit courses, and that at least one half of
the required units be offered in university graduate credit
courses in which regular grades (A, B, C) have been earned.
(For specific degree requirements, consult the section on aca-
demic 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 fun-
damental knowledge of the fields of the major and minor sub-
objects of study. It shall include written portions covering the
major and minor fields and, no later than six months after suc-
cessful 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 consulta-
tion with the major and minor department. No later than three
weeks prior to the proposed date of the examination, the
Request to Schedule Preliminary Oral Examination must be
filed with the Graduate College. The preliminary examination
will be held when essentially all course work has been com-
pleted 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 Coun-
cil. 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 pre-
liminary examination, and showing evidence of ability to do
original research, the student will be recommended to the
Graduate Council for acceptance as a candidate for the docto-
rate. These requirements must be met no later than three
months prior to the date of the final oral examination.

Dissertation

No later than three weeks prior to the proposed date of the final
examination,* the completed Final Oral Examination Request
Form is filed with the Graduate College. The Request Form
shall be accompanied by a copy of the penultimate draft of the
dissertation to be delivered to the Graduate College repre-
sentative appointed to the examining committee. Following the
examination, the Graduate College representative returns the
Notice of Completion of Final Examination and Dissertation
Requirements to the Degree Check Office. The candidate sub-
mits to the Graduate College for review a final copy of the
complete dissertation (approved and accepted by the major
department and all members of the examining committee),
along with the approval pages and special abstract. After mak-
ing any required corrections, the candidate submits two com-
plete 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 Educa-
tion 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 microfilm-
ing 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 infor-
mation is sent to the Library of Congress for printing and dis-
tribution of cards for depository catalogs and libraries. The
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Publication by microfilm does not preclude publication by
other means later, and successful candidates are urged to sub-
mit dissertation material for publication in a scholarly or profes-
sional 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.

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lege 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 Philoso-
phy, see above.)

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

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with the Office of Student Services in the College of Education
or the appropriate division for information regarding the status
and requirements of all programs and degrees.
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.

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

All requirements for the degree of Doctor of 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, educational psychology, elementary education, foundations of education, higher education, reading, rehabilitation, secondary education or special education. The student may minor either inside or outside the College of Education as approved by the Office of Student Services in the College of Education, 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. The 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 should be submitted for approval by the Graduate Council on a form provided by the Graduate College prior to the completion of half of the non-dissertation units proposed. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level or above, university-credit courses, and that at least one half of the required units be offered in university graduate credit courses in which regular grades (A, B, C) have been earned. (For specific degree requirements, consult the section on academic departments.)

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

Advancement to Candidacy

After passing the preliminary examination and giving evidence of ability to carry on professional studies at the highest level, the student will be recommended to the Graduate Council for acceptance as a candidate for the doctorate. These requirements must be met not later than three months prior to the final oral examination.

Dissertation

No later than three weeks prior to the proposed date of the final examination, the completed Final Oral Examination Request Form is filed with the Graduate College. The Request Form shall be accompanied by a copy of the penultimate draft of the dissertation to be delivered to the Graduate College representative appointed to the examining committee. Following the examination, the Graduate College representative returns the Notice of Completion of Final Examination and Dissertation Requirements to the Degree Check Office. The candidate submits 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 cardsets 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. Successful candidates are urged to submit dissertation material for publication in a scholarly or professional journal. Suitable acknowledgement must always indicate the publication to be a dissertation or portion of a dissertation, submitted in partial fulfillment of the requirements for the degree of Doctor of Education at the University of Arizona.

Final Examination

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

Doctor of Musical Arts

The School of Music, through the Graduate College, accepts prospective candidates for the degree of Doctor of Musical Arts. The degree is granted in the fields of composition, conducting, and performance. It is not granted merely as a certificate of faithful performance of a prescribed program of studies but requires demonstration of distinguished attainment. Information about the Doctor of Philosophy degree with a major in music theory or music education will be found under "Music" in 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 two regular semesters of essentially full-time academic work in the Doctor of Musical Arts program in actual residence at the University of Arizona, and at least 30 units of graduate credit must be completed at this institution. Any semester during which a student is registered for at least 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.

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 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 should be submitted for approval by the Graduate Council on a form provided by the Graduate College prior to the completion of half of the non-recital/dissertation units proposed. The program must conform to the requirements set forth in this catalog and those issued from time to time by the Graduate Council, including the general requirement that the required units be offered in 500-level
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 to Schedule Preliminary Oral examination must be filed with the Graduate College. The preliminary examination will be held when essentially all course work has been completed and in any case not later than three months prior to the date of the final oral examination. No student will be permitted a second attempt to pass the preliminary examination except upon recommendation of the examining committee, endorsed by the major faculty and approved by the Graduate Council. The second examination, if approved, may not take place until four months from the date of the first examination. The only visitors permitted at the preliminary examination are regular University faculty members.

**Advancement to Candidacy**

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

**Final Examination**

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

**Specific Requirements for the Major in Composition**

Approval of a major in composition will be based upon evidence of creative talent and a knowledge of craftsmanship in writing music:

In lieu of a dissertation, the candidate will compose a major work of approximately thirty minutes duration. Registration for eighteen units of dissertation credit (920) is required during the preparation of the composition with a maximum of nine units during any regular semester. A penultimate draft of the composition must accompany the Request to Schedule the Final Oral Examination. Following the examination the candidate submits to the Graduate College a final copy (approved and accepted by the School of Music and all members of the 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, if 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.

**Specific Requirements for the Major in Performance**

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

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

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

Curricular Change—Course listings in the following departmental sections are subject to change. Curriculum changes approved during the first year of the catalog's biennium are listed in the Supplement to the University of Arizona Catalog, published approximately one year after publication of the biennial catalog. A copy of this publication is available upon request from the University Curriculum Office, Administration Building, Room 412c.

Class Schedules—Because the catalog designation of semesters of offering is subject to change, students should consult the Schedule of Classes for curricular planning of a particular term. Schedules for fall and spring classes are available at the Information Desk of Registrar Data Processing, Administration Building, Room 210, in April and October, respectively. The Summer Session Schedule of Classes is available in February at the Administration Building, Room 210. For a complete statement of the student's responsibility in maintaining acquaintance with current university requirements, see the copyright page of this catalog.

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

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

Course Numbering System

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

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

600-699: Graduate courses. Not open to undergraduate students.

700-799: Graduate courses limited to doctoral students.

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


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

Year Courses (Double Numbers)—A course designated by a double number (as Pol. 610a-610b) is continued through two successive semesters, the work of the first semester being prerequisite to that of the second unless otherwise indicated in the statement of prerequisites. Credit is awarded for the first half of the course except in a few instances when credit in the first half is contingent upon completion of the second half.

Course Description Explanation

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

Sample Course Listing:

506. Social Structure in Modern Societies (3) [Rpt. ] 1989-90
Critical review of modern theory and research on social structure and social organization in modern societies. 2R, 3L. P, 6 units of sociology or CR. (Identical with Hist. 506) Smith

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.

1989-90—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, and S indicate "recitation," "laboratory," and "studio." 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 lecture and recitation periods only, the number of class hours per week is the same as the unit value and is not specified in the course description.

P—Prerequisites. 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 course description is shown in the course list of the department with instructional responsibility for the course. If no course description appears, consult the crosslisted department.

Smith—Professor in charge.

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

University-Wide “House-Numbered” Courses

Most University of Arizona courses use a combination of lectures, discussions and laboratories as their basic teaching format. University-wide "house-numbered" courses identify alternative teaching formats which emphasize student participation, typically in small group or individual settings. Small-group courses are identified by numbers ending in 91, 93, 94, and 99, as well as all 900-level courses. Under their generic numbers and titles, and without subscripts, they are available for use by all departments at the course-number levels appropriate to the departments’ academic programs.

Small-Group Courses

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

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

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

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

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

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

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

Individual Studies

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

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

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

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

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

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

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

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

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

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

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

Grades Available: S/P, C, D, E, 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.
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) 621-2262

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

The department offers a program leading to the Master of Accounting degree with a major in accounting. The department also participates in programs leading to the Master of Business Administration, Master of Public Administration, and Doctor of Philosophy (major in business administration) degrees. For information concerning these degrees see Requirements for Master'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.

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

522. Advanced Federal Taxation (3) II Introduction to advanced topics: taxation of corporations and stockholders' transactions in stocks; taxation of partnerships and fiduciary gifts; estate and gift taxation.

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.

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

525. Tax Aspects of Real Estate Transactions (3) I 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.

526. Taxation of Partnerships (3) I 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) I II A professional course for those who wish 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) I II Case studies and text readings focused on utilization of accounting data in determining the possible results of alternative executive decisions. Advanced degree credit available for nonmajors only. Open only to students admitted to BPA graduate programs. P. 550, Econ. 500a or CR, M.A.P. 552 or CR.

553a-555b, Financial Accounting (3-3) 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 programs. Not open to accounting majors. Credit allowed for this course or 320, but not for both. P. 210 or 551.

557. Design and Control of Production Systems (3) II (Identical with M.I.S. 557)

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) 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) I II

Aerospace and Mechanical Engineering (AME)

AME Building, Room 301
(602) 621-2236

Professors Chuan F. Chen, Head, Roger A. Anderson (Emeritus), Francis H. Champagne, Harvey D. Christensen (Emeritus), Hermann F. Fassel, Hussein A. Kamel, Dimitri B. Keciglo, Robert B. Kinney (Emeritus), Donald M. McEllogit (Emeritus), Edwin K. Parks (Emeritus), Henry C. Perkins, Jr., Russell E. Peterman, Robert B. Prikakos, Lawrence B. Scott, Jr., William R. Sears (Emeritus), Quentin R. Thomson (Emeritus), Thomas L. Vincent, Paul H. Wirsching, I.J. Wygnanski, A. Ralph Yappel (Emeritus)

Associate Professors Thomas F. Balsa, Kee-Ying Fung, Edward B. Haugen (Emeritus), Juan C. Heinrich, Edward J. Kerschen, Seth H. Lichter, Parviz E. Nikravesh, Kumar N.R. Ramohalli, Bruce R. Simon

Assistant Professors Ara Araybany, Cho Lik Chan, Abhijit Chandra, Ai Glezer, Shiv P. Joshi, Alfonso Ortega, Arne J. Pearsestein, Robert A. Peterson

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

A Bachelor of Science degree from an aerospace or a mechanical engineering curriculum of a recognized institution of higher education is required of applicants to the graduate program. In general, a grade average of "B" or better in previous academic work is expected. Graduates from other engineering, mathematics, and physical sciences curricula may be admitted provisionally. All applicants must submit scores from the Graduate Record Examination general test 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, structural mechanics, fluid systems, propulsion, and power; and advanced work in 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 531a-531b as a substitute.) Normally, no more than three units of independent study or special projects courses may be taken for degree credit. All students are expected to attend the weekly graduate seminar. A final oral examination is required.

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

503. Modeling and System Identification in Dynamic Engineering Systems (3) I 1989-90 Principles of mathematical modeling of engineering problems; state and parameter identification techniques; lumped and distributed system; open loop (explicit) and closed loop (implicit) applications; frequency and time domain representation; deterministic and stochastic inputs. P. 310, CR. 405.


505a. Advanced graduate study in the area of control and the designs of a pre-licensing examination may be scheduled. Written examination on the major subject is given after the student has passed the written examination on the minor subject. Minor subjects may be chosen from other engineering, physics, physical sciences, or mathematics departments. All students are expected to attend the weekly Aerospace and Mechanical Engineering Seminars.

505. Engineering Quality Control (3) II (Identical with S.I.E. 506)

507. Advanced Quality Control (3) I (Identical with S.I.E. 507)


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

511. Advanced Finite Element Analysis (3) I (Identical with C.E. 511)

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

513a-513b. Reliability and Quality Assurance (3) I-II Reliability and maintenance; failure mechanisms; statistical analysis; reliability data; Bayesian estimation and decision theory; elementary stochastic process. P. Math. 413/513a, 464.

517. Clinical Engineering (3) II (Identical with C.E. 517)

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

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


523. Probabilistic Mechanical Design (3) I Application of probability theory and statistics to mechanical and structural design; modern mechanical reliability methods; design philosophy. P. C.E. 217; CR. 409.


527. Design for Manufacturing (3) I Design methodology—axiomatic, algorithmic, hybrid; application to general manufacturing processes—metal forming, metal cutting, welding. P. 436 (AI programming ability; knowledge of plastics required.

528. Advanced Reliability Engineering (3) II Extension of 408; Complex systems reliability; maintainability engineering; reliability and availability; system effectiveness; maintainability demonstration. P. 408, S.I.E. 420. (Identical with S.I.E. 528)


538. Composite Materials (3) II Classification and characteristics of composite materials; mechanical behavior of composite materials, adhesives, structures and multibody systems; application to other disciplines. P. 436. (Identical with E.M. 539)

539. Advanced Structural Mechanics (3) II Advanced problems in structural analysis using the finite element method; analysis and optimization of complex systems; nonlinear and coupled fields; structures and fluid systems; application to other disciplines. P. 436.

540. Advanced Thermodynamics (3) I Reversible and irreversible macroscopic thermodynamics; selected engineering applications. P. 240, 331a.

541. Finite Element Analysis in Nonlinear Solid Mechanics (3) I Finite element methods, including material nonlinearity (elastic, plastic, viscoelastic); geometric nonlinearity (finite deformations), nonlinear material models, and nonlinear programs. P. 436.

542. Convective Transport Phenomena (3) I Convective energy, mass and momentum transport in both laminar and turbulent flow; approximate and exact solutions; application to current problems. P. 442, CR. 532a, computer programming ability.


556. Combustion Gasdynamics (3) II 1989-90 Aerothermochemistry; fluid mechanics, ther- modynamics, chemistry of propulsion and air pollution; reaction kinetics, combustion stability, detonation; singular perturbations in deffagrations. P. 461, 532a.

559. HVAC System Design (3) II (Identical with N.E.E. 558)

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


585. Biomedical Engineering (3) I One subject related to or from biomedical solids mechanics (orthopedic, vascular, muscle, skin); feedback control (physiological systems); heat transfer, thermodynamics (temperature regulation, heat transfer, devices), instrumentation. P. 310, 331b, CR. 400.
504. Production Economics (3)  I Theory of the firm and industry; single and multiple products; risk and uncertainty. (Identical with Econ. 504) Wilson

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

513. Agricultural Price and Marketing Analysis (3)  II Market organization, efficiency, and functions in agricultural economy. (Identical with Econ. 513) Faminow

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

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


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

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

544. In the Wake of the Green Revolution (1)  [Rpt. /2] (Identical with Anth. 544)

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

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

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

550.* Agricultural Economics (3)  I I Applying business and economic theory to problems confronting agribusiness firms in the acquisition, allocation, control, and transfer of capital resources. P. 519. Fox/Finical. 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. (Identical with Econ. 559 and Anth. 559) Fox/Finical

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

571.* Problems in Regional Development (3)  II (Identical with GeoG. 571)

575.* Economics of Water and Land Resources (3)  I Economic analysis of policy issues in rural and urban water use and development. Economic analysis of multiple uses of public lands. Available for Honors. Con- sult department for information. P. 476, or Econ. 361. (Identical with Econ. 575 and R.N.R. 575) Martin


May be convened with 400-level course.

Agricultural Education (AED)

507. 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. W.R.A. 577, and Ws.M. 577) Corby

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

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

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

540. International Agricultural Extension Education (3)  I I Identification and discussion of a number of critical factors peculiar to agricultural extension and rural development in developing countries. Working and living overseas; country studies.

542. Education for Agricultural Entrepreneurship (3)  I Pedagogy of developing motivation, skills and knowledge needed to start small enterprises in agriculture. Field trips. P. 6 units of macro/microeconomics with emphasis upon appropriate disciplines.
504.† Irrigation Principles and Management (3) I Principles of operating farm irrigation systems. Evaluation of design criteria. Basic irrigation scheduling. Flow rates and water application criteria. P, 455 or 456. Larson
505.† Irrigation Engineering Laboratory (2) I 1989-90 Analysis of design and operating criteria for existing irrigation systems. Field trips. P, 455.
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, Yiayay
513.† Agro-Biosystems Process Engineering (3) I 1990-91 Application of basic engineering and biological principles to equipment and methods for processing, handling, refrigerating and drying food, biological, and agricultural materials. 2R, 3L. P, A.M.E. 240 or C.E. 206.
523.† Agricultural Systems Analysis and Design (3) II 1990-91 Application of systems analysis to agricultural and biologically related problems; computer modeling and use of operations research methods. P, Math. 254. Larson
547.† Sensors and Controls (3) I 1990-91 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. 3L. P, E.E. 207, 208.
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, 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. Fee.
552. Irrigation Water Supply (3) II 1990-91 Irrigation water delivery including operation and management of district and farm systems, analysis of flow measurement devices, pumps and wells for irrigation. Field trip. P, 455.
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.
565.† Food Engineering (3) II 1990-91 Fundamentals of fluid flow, materials handling, heat transfer, refrigeration, freezing and drying as applied to food processing. (Identical with N.F.S. 565).
605. Soil-Water Dynamics (3) II 1990-91 (Identical with C.W. 605).
624. Advanced Irrigation Management (3) II 1989-90 Irrigation scheduling using Jensen-Haise and Penman equations for predicting evapotranspiration; determination of crop coefficients; production economics; and energy considerations. P, 404 or 455 or S.W. 520.

*Not available during the Cooperative Extension Service Winter School.
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 engineering .......... M.S.
irrigation engineering .......... Ph.D.
Animal Sciences
animal science .......... M.S.
dairy science .......... M.S.
poultry science .......... M.S.
Entomology
entomology .......... M.S./Ph.D.
Nutrition and Food Science
dietetics .......... M.S.
food science .......... M.S.
Nuttritional Sciences
nutritional sciences .......... M.S./Ph.D.
Plant Pathology
plant pathology .......... M.S.
Plant Protection
plant protection .......... M.S.
Plant Sciences
agronomy and plant genetics .......... M.S./Ph.D.
horticulture .......... M.S./Ph.D.
Renewable Natural Resources
landscape architecture .......... M.L.Arch.
range management .......... M.S./Ph.D.
Renewable natural resources
studies .......... M.S./Ph.D.
watershed management .......... M.S./Ph.D.
The Department of Political Science offers a Master of Arts degree 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 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.

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 (AIMS)
Social Sciences Building, Room 324 (602) 621-7108
Committee on American Indian Studies (Graduate)

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

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

The Committee on American Indian Studies offers a Master of Arts degree with a major in American Indian studies that is designed to prepare students to teach at the college and university level and to work in community development and social programs. Applicants must submit scores on the Graduate Record Examination, two letters of recommendation, and the personal and academic data called for on the American Indian Studies application form. Applicants are also invited to submit vitae, published articles or other materials relevant to admission.

Master 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 of concentration chosen from a field of anthropology, archaeology, 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.

American Indian Studies: 30 units, plus a six-unit thesis. 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 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: The oral and oral tradition. 502a is a first-year course for students in the oral tradition. 502b is the senior-year course in American Indian studies. 


May be convened with 400-level course.

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 junctures.

595. Colloquia

a. Theory and Indian Studies (3) II P, 484a-484b or 502a-502b.

596. Seminar

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

m. Studies in the Oral Tradition (3) [Rpt./9 units] II (Identical with Engl. 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, Bryant Benson, Mac E. Galvez, Philip H. Kutzsch, Associate Professors David E. Blask, Mary J. C. Hendrix, C. Ward Kischer, Albert V. LeBouton Assistant Professor Christopher A. Leadem

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

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

Degrees

Master of Science: This degree is offered only in rare instances when individuals qualified to study for the doctorate are forced to terminate study. The dissertation must be written based upon original research, and reading proficiency in one foreign language are required.

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

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

502. Principles of Neuroanatomy (4) II Cellular elements and recognized subsystems of the mammalian nervous system, with emphasis on general principles of organization and their functional significance. Not open to premedical students. P, 8 units of biological lab. science; 401; Psych. 302, Psio. 480 desir-

550. Topics in Pigment Cell Biology (2) I Selected topics on the development function and control of normal and abnormal pigment cells in various mammalian and avian systems. (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 (3) I (Identical with M.C.B. 557)

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

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)

*May be convened with 400-level course.

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

583. Topics in Neural Plasticity (2) (1) 1990-91 (Identical with M.C.B. 583)

584. Cellular and Molecular 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 Nrsc. 584)

586. Principles of Cellular and Molecualr Neurobiology (4) I (Identical with M.C.B. 586)

589. Principles of Systems Neurobiology (II) II (Identical with Nrsc. 589)

590. Colloquium

d. Special Topics in Cell Biology (2) [Rpt./6 units] II (Identical with C.Bio. 595d)

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

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

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

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

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


616. Introduction to Anatomical Literature (1) I A bibliographically 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.
508. *Anthropology and Public Policy (3) II
Examines the development, goals, techniques, and practices of anthropology as a policy science.

509. *Economic Anthropology (3) II
Analysis of production, exchange, distribution, consumption, and economic systems.

511. *Anthropology of Religion (3) I
Comparative study of religious systems, ritual practices, and their social functions.

512. *Ethnology of the Southwest (3) II
Focuses on prehistoric and historical cultures of the southwestern United States.

514. *Late Quaternary Geology (3) I (Identical with Geols 514)

515. Cultural Ecology and Agrarian Societies in the Middle East (3) II
Emphasis is on land tenure, Islamic land laws, and agricultural development in the Middle East and North Africa.

516. *Contemporary Indian America (3) II
Historical development and contemporary significance of Native American cultures and tribes.

517. *Cultures and Societies of Africa (3) II
Focuses on economic and cultural systems of ancient and modern African societies.

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

519. *Psychological Anthropology (3) II
The study of behavioral adaptations and psychological processes in human societies.

520. *Contemporary American Culture (3) II
Focuses on contemporary issues in American culture, including politics, economics, and social change.

521. *Ethnology of North America (3) I
Focuses on Native American cultures and their histories.

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

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

527a. *The Prehistory of East Asia (3) I
Focuses on prehistoric cultures and the development of early agricultural societies.

527b. *The Archaeology of Pre-Han China (3) II
The origins and development of Chinese culture and civilization.

529. *The Archaeology of Pre-Han China (3) II
Focuses on the origins and development of Chinese culture and civilization.

530. *The Anthropology of Visual Art (3) II
Explores the cultural significance and historical development of visual art in various societies.

531. *Peoples of the Pacific (3) I
Focuses on Polynesian, Micronesian, and Melanesian cultures and their histories.

532. *Kinship and Social Organization (3) II
Focuses on comparative analysis of social structures and kinship systems.

533. *Principles of Archaeological Fieldwork (3) II
Focuses on the principles and practices of archaeological fieldwork.

534a-534b. *Cross-Cultural Communication (3-3) (Identical with A.In.S. 534a-534b)

537a-537b. *Readings in Akkadian (3-3)
Readings in the Akkadian language, focusing on historical and cultural contexts.

539a-539b. *The Anthropology of Visual Art (3-3) (Identical with A.In.S. 539a-539b)

540a-540b. *Cultural Adaptation (3-3) (Identical with A.In.S. 540a-540b)

541. *Organization of Museums (3) I
Focuses on the management of museums and museum studies.

542. *Museum Collections Management (3) I
Focuses on the acquisition, documentation, and management of museum collections.

543a-543b. *The Anthropology of Neolithic and Bronze Age Europe (3-3) (Identical with A.In.S. 543a-543b)

544. *In the Wake of the Green Revolution (1) [Rpt.]
Survey of agricultural and fisheries production and policy following the Green Revolution.

545. *Museum Exhibition (3) II
Focuses on the planning, design, and implementation of museum exhibitions.

546. *Writing Culture (3) [Rpt.]
Focuses on the role of writing in cultural production and sociality.
of other cultures to examine the assumptions of our own. Comparison of ethnographic evidence and artifact collections.

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

551. Archaeology of North America (3) I Intensive review of the development of human culture in North America from the time of the initial peo-

ling of the New World to the historic period.

552R. Archaeology of the Southwest (3) I Development of culture in the prehistoric South-

west from the late Paleozoic to the historic period.

552L. Archaeology of the Southwest (3) II The interpretation of data recovered in the Southwest, with emphasis on their potential for the drawing of both cultural and chronologi-

cal inferences.

553. Mesoamerican Archaeology (3) I Development of culture in Mexico and Central America from the early hunters and gatherers through the conquest of the Aztecs and Mayas by the Spanish.

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

555. Ethnoarchaeology (3) I History, method, and theory of ethnarchaeology with case studies of the use of ethnography in archaeological interpretation and theory-building.

556a-556b. Old World Prehistory (3-3)* II A survey of the main phases in human evolution and early development of cultivated plants in general, with attention given to crop plants of worldwide economic importance and selected crops of local economic importance. Three-day field trip.

557. Prehistoric Mesopotamia (3) I Theories of the rise of civilization tested against archaeo-

logical data from Mesopotamia with compara-
tive material from other areas. Time period: end of the Paleolithic to historic (Sumerian) civilization.

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

561. Paleoeindian 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, history of the field of the Americas. Field trip. (Identical with Geos. 561)

562. Archaeological Quantitative Methods (3) I An intensive review of the theory and applica-
tion of statistical and mathematical methods to archaeological data.

563. Evolution of Ancient States and Civiliz-
ations (3) II 1990-91 Classical and modern the-
ories used to explain the rise of ancient states and civilizations are evaluated as systems of anthropological logic and for their ability to elu-
cidate the archaeological record. Major topics include the nature of growth trajectories, vari-
bility 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 Dendrochronol-
yogy (3-3) (Identical with Geos. 564a-564b)

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

566. Paleoanthropology (3) I Evidence for human and nonhuman primate evolution includ-
ing laboratory study of fossil casts and modern skeletal biology.

567. Race and Ethnic Relations (3) I (Ident-
tical with Soc. 567)

568. Human Osteology (3) I Human osteology for the archaeologist and physical anthropolo-
gist, techniques of in situ and laboratory identi-
fication, 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 adaptive plasticity, including physiological, nutritional, and epidemiological factors. 570a includes discussion of the biology of human aging. (Identical with Gero. 570a)

573a. Primatology (II) Comparative pri-
mate functional anatomy from an anthropologi-
cal viewpoint including extensive laboratory dissection and study of behavior, ecology, and evolution.

574. Ethnobiology (3) II Survey, with empha-
sis on cultural uses of plants, both past and present; discussions of contributions to the theory and techniques of the emergence of agri-
culture, archeological botany, ethnomedicine, and other aspects of ethnobotany.

575. Origins and Development of Cultivated Plants (3) I Evaluation of theories of origins and early development of cultivated plants in general, with attention given to crop plants of worldwide economic importance and selected crops of local economic importance. Three-day field trip.

576. Language in Culture (3) II Survey of the nature and role of language in human societies, including the history of language and other cultural phenomena. (Identical with Ling. 576)

577. Language and Materials Technology (3) I Investigates the ways in which systems of tech-
nology are embedded in a cultural context and the resulting impacts on invention, innovation and communication, 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.

581. Quaternary Palynology (4) II 1989-90 Analy-
ysis and cross-cultural comparison of patterns of communication in discourse; modern approaches to discourse and text. (Identical with Ling. 577)

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

584a-584b. Akkadian Linguistics (3-3) I Introdu-
tion to the standard literary language of the Babylonians and Assyrians. (Identical with Or. S. 584a)

585. Social Organization of India and Paki-
stan (3) I (Identical with Or. S. 585)

586. Comparative Community Development (3) I The application of the results of case studies in economic development in developing countries. (Identical with A. Ed. 586)

587. Poverty and Health (3) II (Identical with Nurs. 587)

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

589. Anthropology and Education (3) I II The application of anthropological theory and methods to education. (Identical with A. Ed. 589)

590. Colloquium a. Bilingual Health Communication (3) I (Identical with Nurs. 595a)

596. Seminar a. The Dynamics of Human Subsistence (3) II 1989-90 Consult department before enrolling.

597. Workshop a. Physical and Forensic Anthropology I (2) I (Identical with Or. S. 596q, which is home)

598. Seminar a. Physical and Forensic Anthropology II (2) I (Identical with Or. S. 596q, which is home)

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

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

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

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

664. Field Civilizations (3) I (Rpt.) 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, or 460.

665. Survey of Physical Anthropology (3) II Modern physical anthropology including evolu-
tionary theory, genetics, skeletal biology, pri-
matology, paleoanthropology, human growth, adaptability and demography.


679. Language and Ethnography (3) II 1990-91 Training in the use of ethnographic method in linguistic and cultural research with emphasis on the use of data. Analysis of data from observation, tape recording and videotaping. P, 6 units of linguistics.

680. Survey of Linguistic Anthropology (3) II Historical and theoretical 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 2A, 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 Or. S. 696b)

697. Colloquium a. Linguistic Anthropology (1-3) [Rpt./3] II b. Physical Anthropology (1-3) [Rpt./3] II d. Musesology (1-3) [Rpt./3] II

Applied Mathematics (APPL)

Mathematics Building, Room 414
(602) 621-4664

Committee on Applied Mathematics (Graduate)

Professors David W. McLaughlin, Chairperson

(Applied Mathematics and Mathematics),

David Arnett (Physics), Bruce R. Barrett (Physics),

Harrison H. Barrett (Radiology), Peter Carruthers (Physics), James M. Cuan-
Students have considerable flexibility in the design of their individual programs. The program attempts to draw out from young men and women their ability to think maturely and more laterally and to train them in all facets of modern applied mathematics. Standards are high but everyone who has made successful careers in industry and academia.

For both the master's and doctoral degrees, student programs are quite flexible and individually designed. Essentially, their basic structures involve a first year core of courses in mathematics, a number of other courses both inside and outside the Department of Mathematics, and participation in a problem seminar. Entering students are expected to know advanced calculus and basic probability theory, although they can take such courses as graduate students. The core includes numerical analysis, principles of analysis, and formal methods of applied mathematics. In the problem seminar, different faculty members (primarily nonmathematicians) present in-depth analysis of problems arising in their research. A student's field in mathematics applies mathematics to a problem arising in an applied discipline or develops mathematical methods for a class of such problems.

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

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

Arabic

(See Oriental Studies)
551.* Topics in Architecture (6) I Design studio option in one of the following: desert architecture, preservation, community design, building technology, entrepreneurial architecture, computer-aided design, design competitions, design technologies, and energy conscious design. Offerings are limited by faculty availability and all topics are not offered each year. Other topics may be introduced.

559.* Ethics and Practice (3) I Standards and values for architectural services and professional project and practice management.

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.

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

577. Lecture 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 environments. Projects analyzing actual settings provide the design application.

580.* Computer Applications in Architecture (3) II 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.

584.* Planning the Built Environment (2) I A lecture survey course 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. (Identical with Ping. 584)

586. Seminar a. Readings in Architecture (2) [Rpt./1] I Human, social-cultural use of space including processes of symbolic expression. Investigations of the role of space through ethnographic readings describing both ritual and architectural examples. Consult college before enrolling.

597. Workshop a. Architecture (3-8) [Rpt./1] II Open to majors only. (Identical with Png. 597a)

b. Special Projects in Architecture (1-3) [Rpt./6 units] I II S Consult college before enrolling.

c. Community Design for Non-Designers (3) I Field trips. Open to nonmajors only. (Identical with LAr. 597h and Png. 597h)

*May be converted with 400-level course.

Arid Lands Resource Sciences (ARL)

845 N. Park Avenue, Room 102 (602) 621-7896

Committee on Arid Lands Resource Sciences (Graduate)

Professors Paul G. Bartels (Plant Sciences), Robert B. Bechtel (Psychology), Herbert E. Carter (Emeritus, Biochemistry), Stanley Davis (Hydrology), Peter F. Flottorp (Watershed Management), Martin M. Fogel (Water- shed Management), Stanely J. Fox (Agriculture, Hydrology), Lay J. Gibson (Geography), Gail G. Harrison (Family and Community Medicine), Varda Heyman (Anthropology), Helen M. Ingram (Political Science), Paul S. Martin (Geosciences), Fred S. Matter (Architecture), James W. O'Leary (Molecular and Cellular Biology), Stanley J. Olsen (Anthropology), Richard W. Reeves (Geography), Michael Schiffer (Anthropology), Donald Slack (Agricultural Engineering), Thomas Tucker (Soil and Water Science), Thomas Weaver (Anthropology).

Associate Professors Charles F. Hutchinson, Chairperson, David Barkley (Agricultural Economics), Michael E. Bonine (Geography, Oriental Studies), Dennis C. Cory (Agricultural Economics), Owen K. Davis (Geosciences), Michael J. Donaghy (Ecology and Evolutionary Biology), Merle D. Farnsworth (Agricultural Economics), Kenneth E. Foster, Joseph J. Hofmann, Eric A. Monke (Agricultural Economics), Michael H. Martin (Anthropology), Janice C. Wade (Agricultural Economics), Donovan Wilkin (Renewable Natural Resources)

Associate Professors Bonnie G. Colby (Agricultural Economics), Steven P. McLaughlin, Thomas K. Park (Anthropology), Robert Robichaux (Ecology and Evolutionary Biology), Steven E. Smith (Plant Sciences), Barbara Timmermann

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

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

505. Graduate Figure Drawing (3) [Rpt./5] I Special problems in drawing, using the classical medium and graphic media as references for personal expression.

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

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

**Degrees**

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

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

The Master of Arts with a major in art history requires a minimum of 30 units in art history, including three units of 511, six units of 586, and six units of 910. With the approval of the advisor, other courses may be substituted for a portion of the 24-unit art history requirement. A Master of Arts (major in art history): Alternatively, students may be admitted with 18 units of undergraduate credit in art history or with 12 such units plus a substantial amount of credit in related areas of study. For further information contact the Art Department.

Master of Arts (major in art education): Applicants must have completed an undergraduate program in art education or in art with a teaching credential in art. Slides or photographs of previous studio work must be submitted directly to the Department of Art before admission can be considered.

All students must complete at least 15 units in art education courses, including one Art 596 seminar each semester of enrollment; Art 530, and Art 633. Each student must elect to take 3 units of 910, or in lieu of thesis, 3 units of 900. A final oral examination is required.

Special facilities for graduate work include the works devoted to art within the T. E. Hanley Collection of 370 objects, 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 L. F. Hoyer Collection of American art, consisting of more than 100 contemporary American paintings and European, Latin American, and Oriental objects of art; and miscellaneous collections, including the University Print Collection of notable examples of various graphic arts. The Center for Creative Photography houses 50,000 photographic prints, archives of negatives, correspondence and memorabilia as well as a specialized library of over 12,000 volumes. The University of Arizona Museum of Art schedules exhibitions from these collections and, from time to time, other exhibitions of general or special interest.
541. Advanced Photography (3) [Rpt.] I Current trends, philosophies and experimentation in still photography. 2R, 2S.

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

547. Media and Media Book (3) [Rpt./1] I Investigation of the book as a format for presenting visual material; the process of making simple book projects. Open to beginners. 2R, 2S. Field trips. P, 12 units of studio art courses.

548. Video for Artists (3) I II Seniors and graduate students who have previously utilized small-format video camera and editing to expand/compile concepts that have developed in their artistic inquiry. 2R, 2S. Field trips. P, admission by portfolio.

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

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

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

553. Graduate Lithography (3) [Rpt./4] I II Lithography with emphasis on individual research. 6S. P, 9 units of graphic design courses and approval of portfolio by Portfolio Committee.

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

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

559. Graduate Illustration (3) [Rpt./1] I II Exploration of any optical material or phenomena and visual solution to illustration problems. 6S. P, 466, acceptance of portfolio by Portfolio Committee.

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

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

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

581. Readings in Contemporary Art (3) I Discussion of contemporary art and artists, based on assigned readings and slide presentations. Field trips.

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

583. Combining Media (3) [Rpt.] I 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. 6S.

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

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

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

597. Workshop in Art History (3) [Rpt./2] I II Field trips.

600. Painting Concepts (3) [Rpt./2] I II Presentation of one's painting concepts and the conceptions of others. 6S. A discussion of research, related ideas and implications for highly concentrated student and faculty discussions. 6S.

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. 6S.

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 S Studio research and instruction with emphasis on personal creative development. 20S. Field trips. P, 473.

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

680. Graduate Studio (6-10) [Rpt./6] I II 12 units of graduate credit in an area chosen by the student. 6S.

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 non-traditional techniques. 6S. P, 487.

Art History

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. Medieval Art (3-3) 512a: Arts of the nomadic invasions of Western Europe and Hiberno-Saxon, Merovingian, and Carolingian art. 512b: 1899-90 Survey of Ottonian, Romanesque, and Gothic art from A.D. 1000 through 1250. 512a is not prerequisite to 512b. 513a-513b-513c. Renaissance Art in Italy (3-3) I II Painting, sculpture, and architecture in Italy. 513a: 14th-15th centuries. 513b: 15th century. 513c: 16th century. 513a is not prerequisite to 513b or 513c.

514a-514b. Northern Renaissance Art (3-3) 514a: Development of Netherlandish painting during the late 14th through the 15th centuries. 514b: Art of the Reformation (16th century) in Germany and the Netherlands during the late 15th through 1521. 514a is not prerequisite to 514b.

517a-517b. 19th-Century European Art (3-3) I II Painting, sculpture. 517a: From the French Revolution to about 1850. 517b: From about 1850 through impressionism. 6S. 2 units of history or art history.

518a-518b. 20th-Century Art (3-3) Painting and sculpture in Europe. 518a: 1886 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 from cultures of Middle America, with particular attention to the Andean area. 522a is not prerequisite to 522b. (Identical with Anth. 522a-522b)

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

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

526. 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-529d. American Art (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. May be taken in any order. P, 6 units of history or art history.

540. Roman Art and Architecture (3) (Identical with Clsc. 584)

596. Seminar on Art History (3) [Rpt./2] I II 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 Consult instructor before enrolling. (Identical with Anth. 596g)

597. History of Photography (3) [Rpt./4] I II P, 424a or 424b.


693. Internship

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

b. Curatorial Training for Archives of Photography (1-6) [Rpt./12 units] I II Open to students concentrating in museum studies only. P, 12 units of graduate art history courses.

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

d. Archives of Photography: Preservation/Cataloging (1-6) [Rpt./12 units] I II Open to students concentrating in museum studies only. P, 12 units of graduate art history courses.

Art Education

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

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

531. The Nature of Artistic Expression (3) I II A discipline-based study of the visual arts providing knowledge and skills necessary to understand and discuss works of art in an
650. Art Instruction in Higher Education (3) I, II Philosophy of art learning and teaching in higher education. Training in processes of instruction in art for community colleges. Four-year colleges and universities. P. 15 units of graduate study in art education, art history, or studio art.

Astronomy (ASTR)

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


Associate Professors John Black, William J. Coke, Robert D. Kennicutt, Jr., Charles Lada, Ramesh Narayan, Andrzej G. Paczolczyk, Marcia Rieke, Raymond E. White

Assistant Professors Craig Hogan, Christopher Impey

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

In view of the heavy demand for admission to the graduate program, applicants are required to submit scores from the Graduate Record Examination (Advanced 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 that is 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 candidates must present written theses; the student and major professor submit a thesis proposal for approval. A student who elects to minor in astronomy must complete 12 acceptable graduate units in astronomy including, but not limited to, the following:


- 520. Atomic and Molecular Astrophysics (3) I 1990-91 Interpretation of astrophysical spectra: basic aspects of atomic and molecular spectra and processes that enable one to infer physical conditions in atmospheric environments from observed spectra. Familiarity with basic quantum mechanics is assumed.

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

540. Structure and Dynamics of Galaxies (3) I 1990-91 Observational properties of galaxies; structure, kinematics, star and gas content. Structure of our own galaxy. Dynamics of stellar systems; equilibria, instabilities, internally and externally driven evolution.

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

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

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


556a-556b, Electrodynamics of Conducting Fluids and Plasmas (3-3) 1990-91 (Identical with Pty.S. 556a-556b)

575. General Relativity and Cosmology (3) I 1990-91 General relativity with application to cosmology, black hole, gravitational collapse, gravitational radiation, black holes, gravitational lensing and cosmology. Cocke

582. High Energy Astrophysics (3) II 1989-90 Physics of high energy phenomena, cosmic rays, charged particle acceleration, pulsars, black holes, accretion disks, X-ray binaries, gamma-ray sources, radio galaxies, active galactic nuclei. (Identical with Phys.S. 582)


589. Topics in Theoretical Astrophysics (3) (Rpt.) (Identical with Phys. 589)
Assistant Professors Eric A. Betterton, Joseph A. Zehnder

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees in atmospheric sciences. Research is offered through the Institute of Atmospheric Physics in areas such as fundamental atmospheric processes, condensation, evaporation, atmospheric chemistry, cloud and precipitation physics, lightning and atmospheric electricity, atmospheric dynamics, mesoscale meteorology, and climate change. An undergraduate major or minor in atmospheric science is not required for admission but some knowledge of the field is desirable. Applicants with undergraduate majors in physics, chemistry, mathematics, or engineering are particularly encouraged to apply.

**Degrees**

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

Doctor of Philosophy: In addition to the College requirements, the candidate must demonstrate reading knowledge of a foreign language approved by his or her committee.

521.* Physical Climatology (3) I 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.

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

541a-541b.* Dynamic Meteorology (3-3) Thermodynamics and its application to planetary atmospheres, hydrostatics; fundamental concepts and laws of dynamic meteorology. P, 451a; Math. 254.


551a-551b.* Physical Meteorology (3-3) Introduction to physical meteorology, including atmospheric radiation, fluid mechanics, aerosol physics, cloud physics, and atmospheric electricity. P, 454; Math. 254.

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

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

571.* Synoptic Analysis (3) I 1990-91 Principles of meteorological analysis, including surface and upper-level charts, cross-sections, kinematic analysis, structure of the troposphere and tropospheric systems, thermodynamic diabatic processes. P, 442d.

572.* Weather Forecasting (3) II 1990-91 Techniques for weather forecasting and actual forecasting experience; advanced synoptic analysis of the atmosphere. P, 441b.

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


641. Theoretical Meteorology (3) I Methods of solution of the hydrodynamic equations; identification and analysis of acoustic, gravity, Kelvin-Helmholtz, inertial, Kelvin, barotropic and baroclinic waves. P, 441b.


656a-656b. Atmospheric Optics and Radiation Transfer (3) 1990-91 Theory of atmospheric radiation transfer processes; specific methods for solving relevant equations; applications to problems in radiative transfer and optics. P, Phys. 420. (Identical with Opt. 656a-656b)

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

Bilingual/Bicultural Education

(See Language, Reading and Culture)

Biochemistry (BIOC)

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


Associate Professors Hans J. Bohmert, Don P. Bourque, Jennifer D. Hall (Molecular and Cellular Biology), Martinez Hewlett (Molecular and Cellular Biology), John W. Little, Marc E. Tischler

Assistant Professors Danny L. Brower (Molecular and Cellular Biology), H. Law, P. L. P. (Molecular and Cellular Biology), Carol Dieckmann, Elizabeth Vierzing

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 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 candidate must have completed two years of undergraduate work in biochemistry, biology, or related fields; knowledge of the field is desirable. Applicants to the department must be able to demonstrate proficiency in the following areas: microbiology, biochemistry, and physiology.

The curriculum includes a core of graduate courses in biochemistry, as well as electives selected in consultation with the student's advisor. Students are encouraged to participate in research activities, either through the department's own facilities or through collaborations with other departments.

Research areas in which graduate students may pursue careers include general biochemistry, protein structure and function, gene expression and regulation, cellular biochemistry, molecular and cellular biology, and experimental pathology.

Biochemistry offers opportunities for students to conduct research in a wide range of fields, including enzymology, protein structure and function, gene expression and regulation, cellular biochemistry, molecular and cellular biology, and experimental pathology.

Research areas in which graduate students may pursue careers include general biochemistry, protein structure and function, gene expression and regulation, cellular biochemistry, molecular and cellular biology, and experimental pathology.

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Research areas in which graduate students may pursue careers include general biochemistry, protein structure and function, gene expression and regulation, cellular biochemistry, molecular and cellular biology, and experimental pathology.

563. Biochemistry Laboratory (2) II Introduction to experimentation with biochemical systems, processes and compounds of biochemical importance. IR, SL, P. 460 or 462a, and CR 462b.

565. Enzymes (3) III 1990-91 Advanced consideration of enzyme structure and function. P. 462a, Chem. 480b. (Identical with Chem. 565)

568. Nucleic Acids (3) III Chemistry, structure, and function of nucleic acids; replication, transcription, translation, gene organization, regulation of gene expression and organellar nucleic acids. Both procaryotic and eucaryotic systems will be considered. (Identical with Gene. 568, M.C.B. 568 and N.F.S. 568)


572. Metabolic and Hormonal Control of Cell Function (3) III 1990-91 Advanced treatment of the biochemical aspects of metabolic regulation and hormone action. P. 462a-462b and 575 or consult department before enrollment. (Identical with Chem. 572)

573. Recombinant DNA Techniques (3) II (Identical with M.C.B. 573)

575. Biochemical Techniques (3) I Survey of current techniques used in biochemical research including methods used to study proteins, nucleic acids, membranes, and metabolism. P. 462a-462b. (Identical with Chem. 575)

576. Biophysical Techniques (3) I Survey of current physical techniques used in biochemical research including solution properties of macromolecules, optical spectroscopy, magnetic resonance and x-ray and electron diffraction. P. 462a-462b and Chem. 480a-480b. (Identical with Chem. 576)

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

595. Colloquium

a. Topics in Electron Microscopy (2) [Rpt/2] 1989-90 II (Identical with M.C.B. 595b, which is home)

b. Topics in Food Proteins (3) II 1989-90 (Identical with N.F.S. 665)

611. Introduction to Biochemical Research (1-2) I-II Supervised research experiences in the labs. of individual faculty members. Open only to first-year majors. P, CR, 561a-561b.

696. Seminar

a. Biochemistry I (1-3) I

b. Biochemistry II (1-3) II

800. Research (1-16) Yr.

801. Medical Biochemistry (5)

804. Intermediate Medical Biochemistry (5) I

891. Preceptorship

a. Biochemistry (3-12) [Rpt/12 units]

**Biological Sciences**

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

- Anatomy
- Animal Sciences
- Biochemistry
- Biology (Ecology & Evolutionary Biology)
- Entomology
- Genetics
- Microbiology and Immunology
- Molecular and Cellular Biology
- Neurobiology
- Nutritional Sciences
- Pharmacology and Toxicology
- Physiological Sciences
- Plant Pathology
- Plant Sciences
- Toxicology

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

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

**Biomedical Engineering**

- Electrical and Computer Engineering

**Business Administration**

- BPA Building, Room 230
- (602) 621-2388

**Committee on Business Administration**

Professors William B. Barrett (Vice Dean), Chairperson, Gerald O. Bierwag (Finance and Real Estate), Dipankar Chakravarti (Marketing), William L. Félix, Jr. (Accounting), Roy E. Mäster (Management Information Systems), Jay F. Nunamaker, Jr. (Management Information Systems)

Associate Professors John Z. Drabicki (Economics), Gregory B. Northcraft (Management and Policy)

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

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

**Degrees**

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

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

Candidates must have a bachelor's degree and proficiency in mathematics at the level of Math. 125a-125b. Individual programs may vary to allow for differing backgrounds and to accommodate different special interests. Courses are chosen with the approval of the major and minor advisors to provide a strong theoretical and methodological background for research in the candidate's particular discipline. The program requires a major in one of the concentration 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)


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


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. P. 430.


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

553.* Corrosion (3) II (Identical with M.S.E. 555)

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

551.* Chemical and Physical Fundamentals of Air Pollution (3) II Study of the kinetics, transport phenomena and phase equilibria of urban air pollution problems. P. 305, 430.


560. Aerosol Science (3) I 1989-90 (Identical with Atmo. 560)

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

569. Industrial Energy Utilization and Management (3) II (Identical with N.E.E. 569)


580. Bioseparation Techniques for Engineers (3) II Methods of separation for purification of bioprocess products—amino acids, proteins, nucleic acids, carbohydrates, lipids, cells. P. Chem. 243a-243b.

581. Bileauctor Engineering (3) I Introduction to biotechnology; chemistry of microorganisms; biochemical reactions; bileactors: bile system, bileaectorial cells. P. Chem. 243a-243b.


586. Advanced Biomedical Engineering (3) II Analytical methods applied to problems in biochemical and biomedical engineering. Course includes invited lecturers, journal critiques, and preparation of an original paper. P. Math. 223.


667. Advanced Solar Engineering (3) II (Identical with N.E.E. 667)
Chemistry (CHEM)
Old Chemistry Building, Room 227
(602) 621-2809


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

Assistant Professors Ludwik Adamowicz, Steven W. Buchanan, Daniel P. Dolata, Eugene A. Mash, Jr., Robin L. Post, Mark A. Smith, David E. Wigley

The department offers programs leading to the Master of Arts, Master of Science, Master of Education, and Doctor of Philosophy degrees with a major in chemistry. Concentrations are available in analytical, biochemistry, inorganic, organic and polymer, and physical chemistry; and in the life sciences (biochemistry, molecular biology, and biophysics). Chemistry, mathematics, physics, and psychology. Interdisciplinary fields:

Prospective students should write to the Office of Academic Affairs in the Department of Chemistry for information and brochures about the major program. The facilities include laboratories, chemical physics laboratories, state-of-the-art chemistry, physics, and mathematics laboratories, and several other interdisciplinary fields.

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.

Doctor of Philosophy: The Doctor of Philosophy is a terminal 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) General survey of physical chemistry, including thermodynamics, structure, kinetics and electrochemistry. P, 480b.

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

510a-510b. Advanced Inorganic Chemistry (3-3) I II Survey at the advanced level of the chemistry of the elements. P, 480b.

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

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


521. Advanced Instrumental Analysis (3) Topics in spectrophotometry, emission spectrometry, chromatography, electroanalysis, principles of instrumentation and data acquisition for advanced spectroscopy. P, 480b.

522. Electroanalytical Methods (3) II 1990-91 Principles of electrochemistry and electroanalysis, including topics on electrochemical equilibrium and kinetics, potentiometry, voltammetry, amperometry, coulometry, chronopotentiometry, and modern cyclic and pulse methods. P, 480b.


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

525. Chemistry of Metal Chelates (3) 1989-90 Theory underlying the application of chelating reagents in chemical analysis. P, 523.


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

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

540. Organic Reactions and Mechanisms (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. 565)

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 1990-91 (Identical with Bioc. 565)

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

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

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


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

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


614. Organometallic Compounds (3) I 1990-91 Compounds containing carbon- to-metal bonds, with emphasis on those of the transition elements, and the determination of their structures. P, 410.

615. Coordination Chemistry (3) I 1989-90 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 or CR, 510.

616. Chemistry of the Main Group Elements (3) I 1990-91 Theory, structure, and chemistry of the group III, IV, and V elements. The chemistry of the halides, particularly of boron, are emphasized. Current theoretical approaches
618. Computations in Chemistry (3) [Rpt./1] II 1990-91 State-of-the-art computational methods in chemical research, including applications to quantum mechanics and modeling of chemical structures. P, 300. Consult department before enrolling.


642a-642b. Polymer Chemistry (3-3) I 1989-90 Synthesis, stereochemistry, and mechanisms of formation of high polymers. 642a: Condensation and ring-opening polymers. 642b: Vinyl polymers. P, 540. 642a is not a prerequisite to 642b.

644. Heterocyclic Compounds (3) I 1989-90 The behavior of the more important heterocyclic systems. P, 540.


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


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

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

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

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

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

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

Chinese (See Orient Studies)

Civil Engineering and Engineering Mechanics (CE/EM)

Civil Engineering Building, Room 206, (602) 621-2266


Associate Professors Gary L. Amy, Muniram Budhathoki, Mohammad P. Ehsani, Donald B. Hayes (Emeritus), Edward A. Nowotzki, Margareta S. Peterson, Robert H. Wortman

Assistant Professors Robert G. Arnold, Curtis W. Brent, Stephen M. Bryan, Donald C. Cantoni, Konstantinos, Panos D. Kioussis, Tribikram Kundu, Bruce W. Logan, Hamid Samadatmasneh

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in civil engineering and engineering mechanics. Work is directed toward research and professional development in such areas as engineering mechanics, engineering materials, regional development and urban planning, highway engineering, hydrology and fluid mechanics, environmental engineering, geomechanics, geotechnical engineering, water resources, structural engineering, and transportation. Certain interdisciplinary programs are available by combining courses in 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 a large variety of courses, subject to faculty availability and student interest: public works planning and engineering, construction engineering, civil engineering, environmental 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 unsteady flow, heat conduction, 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 Hyd. 503)

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

517.* Strength 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, nonlinear material behavior, membrane stresses in shells. P, 217.

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

522. Hydrodynamic Engineering (3) II Hydrologic analysis, evaluation of site potential, turbine selection, power plant civil works, project feasibility. P, 322, 423 or 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) (Identical with W.R.A. 526)


532. Advanced Strength of Materials (3) II Selected topics in advanced mechanics of deformable bodies.

533. Plastic Analysis and Design (3) II Material and member behavior to full plasticization; redistribution of forces, plastic design of continuous beams and frames; influence of axial and shear forces; deflections and rotations; alternating plasticity; shakedown analysis. P, 436 or consult department before enrolling.

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

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

540.* Foundation Engineering (3) II Settlement and bearing capacity of shallow and deep foundations, subsoil; design of footings and pile foundations; design of 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-planar, and composite-surface methods; analyses for static and steady-flow conditions; earth pressure theories and calculations for generalized conditions; design of rigid and flexible retaining structures; design of braced and tie-back sheet piling 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 applications. P, 344.

547. Seepage and Earth Dams (3) I Principles of flow in porous media; analytical and approximate solutions of confined and unconfined flow; seepage erosion; piping and failure design; earth and rock fill dam construction and design; stability analyses. P, 340.

548. Numerical Methods in Geotechnical Engineering (3) I Brief statements and applica-
tions of numerical methods based on closed-
form solutions, finite difference, finite element and element-free methods for problems involving soil structure interaction such as piles, retaining walls, group piles, underground works; seepage; and consolidation. P. 340, 402, 505.

552. Engineering Surveys (3) I CDT Solar and Polaris observations; mineral, public, and private land surveys; route surveying, curves, and alignments; photography; photogrammetry; and modern engineering surveys. 2R, 3L. P, 251.

554. Photogrammetry (3) II Reading, interpreting, and creating thematic maps. First, interpretative photogrammetry; and aerial photographs; stereoscopic principles and their application in the production of planimetric and topographic maps. 2R, 3L. Field trips. P. 251, Math. 125a.

555. Irrigation Engineering (3) II (Identical with A En. 555).

558. Drainage of Irrigated Lands (3) II (Identical with A En. 558).

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

562. Bituminous Materials (3) II Manufacture and testing of bituminous mixtures in the laboratory. Assignment problems for students involving the determination of optimal testing for the control of bituminous materials used in highway construction and maintenance. 2R, 3L. P. 340 or consent of instructor.

563. Traffic Engineering (3) I Methods for the efficient and safe operation of transport facilities through analysis of capacity, safety, speed, payment, and their interrelationships. 2R, 3L. P. 340.

564. Airport Planning and Design (3) II Location, analysis and design of airports and airport facilities, including aircraft characteristics, mass transit, 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, economic, and physical constraints; study of general and specific 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 Ping. 565).

568. Urban Transportation Planning (3) II CDT Transportation planning in relation to urban development; techniques and procedures for developing long-range regional plans. P. 360 or consent department before enrolling. (Identical with W.R.A. 568).

571. Water Quality Control (3) II Aspects of water quality management, including consideration of social, economic, and physical constraints; study of general and specific 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 W.R.A. 568).

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.

576R. Chemistry of Environmental Engineering (3) I Chemistry of natural waters and water treatment processes. Chemical thermodynamics, equilibria and kinetics in environmental systems.

576L. Environmental Chemistry Laboratory (1) I Laboratory exercises emphasizing the chemistry of natural waters, water and wastewater treatment plants, including related analytical methods. 3L. CR. 576R.

577. The Physiological Bases of Microbial Treatment Processes (3) II Principles of bacte-
rial physiology including morphology, metabolism and genetics. Applications of importance to water treatment and environmental quality. P. 340 or consult with department.

578. Introduction to Hazardous Wastes (3) II Management, planning, legal and engineering aspects of hazardous wastes and their treatment and disposal. P. 370 or 471 or consent department before enrolling.

579. Environmental Air Pollution (3) I Air pollution control, emission control, with special consideration of the meteorological, urban, rural, industrial, and health aspects.

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).


613. Theory of Elastic Stability (3) II Bending and buckling of prismatic bars, beams, rings, curved bars, thin shells, and thin plates under axial and lateral loads. P. 217, 301.

621. Sediment Transport (2) I Erosion, transportation and deposition of sediments by flowing water; sediment properties and their relationship to load and suspended load movement; river bedload and channel. P. 321.

622. Open-Channel Flow (3) II Continuity, energy and momentum principles applied to steady and unsteady flow in open channels; channel conditions, 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. 322.

624. Planning and Design of Multipurpose Water Resources Projects (3) II Design of water resource systems for surface water supply, flood control, hydropower and navigation, either as single purpose or as multipurpose projects; brief review of environmental, economic and legal aspects. Field trips. P. 321, 423 or 523.

625. 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 normal and shear forces; design of beam to column connections and shear walls. P. 437 or departmental approval.

637. Soil-Structure Interaction (3) I 1989-90 Explanation of soil behavior, closed form and numerical solutions, beams, axially and laterally loaded piles and walls, wave equation for piles, group piles, slabs on deformable media. P. 640 or 641 or consult department before enrolling.

640. Advanced Soil Mechanics (3) I Site investigation and in situ testing; shear strength of sands and clays; interpretation of laboratory test results; consolidation theory; one-dimensional infinitesimal and finite strain; slope stability. P. 340.


642. Engineering Characteristics of Soil (3) II Advanced theories of mechanical and physical aspects of soil. Lab testing including index parameters, compaction, consolidation, shear stress, total stress, critical state and plasticity aspects. 1R, 6L. P. 640.


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

662. Design of Rigid Pavements (3) I Analysis of loads, stresses, material characteristics, and traffic 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 roadways, control systems, and analysis of transport systems using environmental and financial factors. P. 463 or 563.


666. Highway Geometric Design (3) II 1990-91 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 1990-91 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.

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. 675R.

673L. Advanced Water-Wastewater Treatment Laboratory (1) I Experiments in physical-chemical treatment of water and wastewater designed to illustrate treatment design principles in that subject area. 3L. CR. 673L.

674. Toxic and Hazardous Waste Treatment (3) II 1990-91 Application of treatment processes for toxic and hazardous wastes described in introductory courses. P. 675R.

675. Wastewater Treatment (3) I 1990-91 Study of geometric elements of streets and highways, with emphasis on analysis and design for safety. P. 463 or 563.
ter and anaerobic digestion designed to illustrate treatment principles. 3L, CR, 675R.
678L. Water Treatment System Design Laboratory. Laboratory 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) I (Identical with C.E. 502)

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

508. Fracture Mechanics (3) II 1990-91 Modes of fracture; crack propagation; Griffith energy balance; crack tip plasticity; J-integral; fatigue cracks; analytical and numerical techniques; constitutive models for damaged materials. P, 505 or consult with department.
511. Advanced Stress Analysis (3) II Approximation functions, Lagrangian and Hermitian interpolation, isoparametric elements and numerical integration; mixed and hybrid boundary element methods, beam analysis, nonlinear problems in solids under static and dynamic loads, time integration schemes, fluid nonlinear problems in solids under static and dynamic loads, time integration schemes, fluid and heat coupled problems and mass transport. P, 402 or consult department before enrolling. (Identical with A.M.E. 511)

539. Advanced Structural Mechanics (3) (Identical with A.M.E. 539)

566. Seminar
b. Geomechanics/Mechanics (1) [Rpt./2] I (Identical with C.E. 566b)

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.


635. Matrix Methods in Structural Mechanics (3) I, II, III Methods of the force and displacement methods; the finite element method, with application to bar, beam, plate, and shell structures; organization and development of computer programs; linear and nonlinear systems. P, C.E. 331 or A.M.E. 436.

537. 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, 539, 604.


Classics (CLAS/GRK/LAT)

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

Professors Norman Austin, Albert Leonard, Jr., Gamel D. Percy (Emeritus), David Soren Associate Professors Jon D. Scofield, Acting Head, Richard C. Jensen, Thomas D. Worthen
Assistant Professors Holt Parker, Mary Voyatzis

The department offers a degree of Master of Arts in majors with a rich in classics with concentrations in philosophy (Greek/Latin) or classical archaeology. The graduate course open, allow graduate students with the permission of the instructor, with the exception of 510, 553, and 599 which are open only to students admitted to the Master of Arts degree program in classics.

Greek (GRK)

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

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

510. Classical Philology (3) (Identical with CLAS 510) Readings in Greek and Latin. P, 3 units of 400-level Greek.

512.* Readings in Greek Philosophy (3) 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.

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

522.* Readings in Greek Drama (3) Close reading in Greek of either (1) tragedy— one play each by Aeschylus, Sophocles and Euripides or (2) comedy—two plays of Anistophanes, one of Menander. P, 3 units of 400-level Greek.

524.* Homer (3) Close reading of selections from the Iliad and Odyssey in Greek and an introduction to the critical secondary literature.

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.

529.* Cicero (3) The life of Cicero illustrated by means of close reading of selected works in Latin (pro Caelio, selections from the Philics, 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.

530.* Latin Paleography (3) Identification and reading of major Latin bookhands of the Middle Ages and the Renaissance. Problems in text transmission, corruption, and emendation. P, 3 units of Latin at the 400 level.

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

558.* History of Byzantium (3) (Identical with CLAS 558) Readings in the history of Byzantium and the Latin East. P, 3 units of 400-level Greek.

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

Classical Literature and Civilization (CLAS)


570.* Greek Philosophy (3) [Rpt./1] (Identical with Phil. 570)

585.* Linguistic and Computer-assisted Approaches to Language (3) [Rpt./6 units] II (Identical with Ger. 585)

588.* History of Byzantium (3) (Identical with Hist. 588)

596. Colloquium
f. Advanced Studies in Ancient History (3) [Rpt./5] II (Identical with Hist. 595f, which is home)

Classical Art and Archaeology (CLAS)

527.* Archaic Greek Sanctuaries (3) Archaeology of the sanctuaries sites from the Archaic period in Greece, both those which became part of the sanctuary and those associated with individual states. Relationships between the polis and the local sanctuary.

543a-543b. *Archaeology of Neolithic and Bronze Age Greece (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. Introduction to Graduate Study in Classical Archaeology (3) An historiographic survey of classical archaeology with discussion of Heinrich Schliemann, Luigi Palma de Cesnola, Charles Folliot McKim and others. 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.

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.

557. Greek Architecture (3) A survey of the architecture and architects of Greece from the Neolithic to Roman periods including such sites as Nea Nikomedea, Aegina, Lerna, Troy, Mycenae, Athens and Corinth. P. 340a-340b.

558. Greek and Roman Provincial Archaeology (3) Survey of classical archaeological sites in ancient Tunisia, Cyprous, Portugal and Turkey. P. 340a or 340b.

559. 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.

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

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 classical architecture and urbanism not only monuments themselves but attempts to consider a building in its physical and cultural setting. P. 340a or 340b.

566. Greek and 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 6584.

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

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

571. Political Communication (3) I Investigation and analysis of communication principles and practices in contemporary campaigns for elective office.

572. Topics in Rhetorical Theory and Criticism (3) [Rpt./1] Intensive reading and analysis of the works of major rhetorical theorists. Each semester will focus on a specific era or perspective.

573. Communication Research Methods (3) II Theories of communication and their research backgrounds; research methodology in communication behavior studies.


575. Communication and the 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.

589. Scholarly Communication (3) II (Identical with Li.S. 589).

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

610. Communication Theory I (3) An overview of research for students considering the field of communication theory, both in verbal and nonverbal communication in the processes of understanding and development of interpersonal relationships.

611. Communication Theory II (3) I An overview of historical and theoretical perspectives on communication strategies used in social influence and interpersonal communication research.

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) II Advanced study of research design and statistical analysis in contemporary communication research.


erature, or (d) GSFLT exam in a second language. (e) TOEFL exam for foreign students. Applicants' linguistic competence to do graduate-level work in the literatures of the particular languages will be judged by a special committee.

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

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

Minor: Students may choose their literatures from the academic units 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 (Amirnane, Chinese, Japanese, and Arabic). (503a is identical with Eng. 503a; 503b is identical with Or.S. 503b)

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

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

696. **Seminar** (See Music)

**Computer Engineering** (See Electrical and Computer Engineering)

**Computer Science (CSC)**

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

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

The Department of Computer Science offers programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in computer science. The Department's programs 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, analysis of algorithms, software engineering, 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, as well as from the Computer Science Subject test. The department requires that two letters of recommendation be submitted.

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

**Master of Science:** 30 units of graduate credit are required, including core courses 510, 552, 553, 573, and at least one Advanced Topic. A thesis is not required, but with departmental approval a student may elect to submit one.

**Doctor of Philosophy:** Doctoral students must complete 42 units of graduate credit in the major including the M.S. core, 520, 545, and 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.

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

510. **Software Design and Implementation** (3) The specification, design, implementation and documentation of complex software systems. Includes a large programming project. P. 327, 430.

520. **Principles of Programming Languages** (3) Global semantics of algorithmic languages, including scope of declarations, data types, retention, block structure, binding time, subroutines, coroutines, extensibility, implementation issues. P. 327, 430.

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; system development through programs; paradigms for distributed programming. P. 452, 473.

532. **Principles of Computer Networking** (3) II Theory and practice of computer networks, emphasizing the principles underlying the design of network software and the role of the communications system in distributed computing. Topics include data representation, channel semantics, synchronization, resource naming, and resource sharing. P. 452, 510.

533. **Computer Graphics** (3) II Theory and practice of computer graphics; design and analysis of graphics algorithms, graphics hardware and device independence, graphics system software, user interfaces, applications. P. 510, Math. 215.

541a-541b. **Computer-Aided Information Systems** (3) Analysis, Design, and Implementation (3-3) (Identical with M.I.S. 541a-541b)

543. **Theory of Graphs and Networks** (3) II (Identical with Math. 543)

545. **Analysis of Algorithms** (3) I Time, space complexity; recurrences; algorithm design techniques; lower bounds; graph, matrix, set
652. 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, 510.

553. Translators and Systems Software (3) II Basic concepts of compilation of block-structured languages. Topics include lexical analysis, top-down and bottom-up parsing, semantic analysis, syntax-directed code generation, debugging. P. 473, 510.

555. Principles of Compilation (3) I Detailed study of more advanced aspects of compilation. Topics include translator writing systems, attribute grammars, flow analysis and optimization, register allocation, code generation. P. 553.


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

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

573. Theory of Computation (3) I II Mathematical preliminaries; finite automata, regular expressions, applications; context-free grammars, pushdown automata, Turing machines, undecidability. P. 227, Math. 243. (Identical with Math. 573)

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

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. 452.

578. Computational Methods of Algebra (3) II (Identical with Math. 578)

579.* Game Theory and Mathematical Programming (3) II 1969-90 (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] I Design and analysis of algorithms; specific topics to be determined by current literature and faculty and student interest.

652. Advanced Topics in Operating Systems (1-3) [Rpt./12 units] I Operating system design, development, analysis, and performance; specific topics to be determined by current literature and faculty and student interest.

673. Microprocessors, Minicomputers and Real-Time Distributed Processing (3) II (Identical with E.E.C. 673)

674. Sequential Circuits and Automata (3) I (Identical with E.E.C. 674)

696. Seminar
   a. Foundations of Computing (3) [Rpt./2] II S P. Ph.D. candidate or consent of department before enrolling.

Conducting (See Music)

Consumer Studies (See Family and Consumer Resources)

Correctional Administration (See Management and Policy)

Counseling and Guidance (See Family and Consumer Resources)

Creative Writing (See English)

Criminal Justice Administration (See Management and Policy)

Dairy Science (See Animal Sciences)

579a-579b.* Advanced Pointe Technique (1-1) [Rpt./4 units] I II 579a: Barre work; continuing development of strength, speed, and stamina. Introduction of advanced barre combinations. Center work; allegro en pointe, also adagio, pirouettes and consecutive turns. 579b: Continuation of 579a with increasing difficulty and complexity in the enchainments. 2S. P. audition.

540a-540b.* Ballet Technique III (2-2) P. 340b. Hancock

541a-541b.* Modern Dance Technique III (3-3) P. 341b. Nielsen

543. Dance Ensemble (2) [Rpt./1] I II Rehearsal method; repertoire, development, and performance of dance with particular emphasis on ensemble. 4S. P. repertory audition; intermediate level in modern and ballet (340a-340b, 341a-341b).

545.* Advanced Choreography (2) I Movement, motif development for solo and group composition. P. 245b, Nielsen

546. Dance Program Administration (3) II 1990-91 Historical and current factors affecting career development in dance and dance-related fields; practical organization of programs. (Identical with Dram. 546) Wilson

550. Literary Resources for Choreography (3) II 1989-90 Studies in primary world literature, in drama, and in psychology of personages as sources for choreographic themes; presenta-
Design and construct such items as masks, prosthetic pieces, wigs and beards. P, 115.

516. Theatre Graphics II: Drafting (3) I Advanced theatrical perspective, scenographic and graphic techniques. P, 120.


520. Special Effects for Theatre (3) II 1989-90 Applied theory and techniques associated with sound and system and visual effects in the theatre. 2R, 3L.

521. Scene Painting (3) I Techniques and methods of scenic painting.

522. Advanced Stage Lighting I (3) I 1989-90 Theoretical and practical study of lighting techniques, including the use of light in production. P, 120.

523. Acting V (3) I Intensive study of classical acting styles with emphasis on Shakespeare.

524. Acting Resources for Choreography (3) II 1989-90 (Identical with Dnc. 550)

525. Acting VI (3) II Intensive study of classical acting styles with emphasis on Commedia dell'arte, Shakespeare, and English Restoration. Individual and group performance. 2R, 2S, P, 205, 449, audition.

526. Acting VII (3) III Rpt. 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.

527. Special Topics in Acting (1-3) I 

528. Special Topics in Design (1-3) I Advanced study and techniques of avant-garde theatre. Rehearsal and performance of select projects.

529. Special Topics in Costume Design (2-3) II Advanced study in current cinematic theory and criticism. Historical examination of major film theories including formalism, realism, classical Hollywood, structuralist, semiotic and feminist film theories.

530. Stage Management (2) I Principles and techniques of stage management, practical applications, problems and analysis of stage management. P, 115.

531. Theatre Publicity and Box Office (2) I Publicity, press releases, sales, advertising, display techniques, subscription procedures. P, 12 units.

532. Theatre Management (2) II Amateur, educational and professional theatre organization and management; theatrical contracts, professional unions and representative organizations. P, 12 units of drama.


534. Sceneography (3) I The integration of scenery, costume, make-up, light and sound into a total production. P, 420.

535. Advanced Stage Lighting III (3) I 1989-90 An advanced study of lighting design for opera and dance; theatrical (light plots) and practical (light lab) projects. P, 420.

536. Advanced Stage Lighting IV (3) I 1989-90 An advanced study of lighting design for musical theatre; theoretical (light plots) and practical (light lab) projects. P, 420.

537. Advanced Scenic Design II (3) I 1989-90 Advanced study of scenic design for opera and dance; research on major historical and contemporary designers; preparation and presentation of design projects. P, 424.


539. Advanced Scenic Design IV (3) I 1990-91 Advanced study for musical theatre; research on major historical and contemporary designers; emphasis on the preparation and display of design projects. P, 429.

540. Advanced Stage Lighting V (3) I 1990-91 Advanced study and exercise in voice and movement for the actor; relaxation, breathing, physical and vocal freedom, resonance, articulation and improvisation including the use of the Lefkowitz Approach, I.P.A., and Neutral Mask. 6S. P, audition.

541. History of the American Theatre (3) II Studies in the American theatre and drama. Directed and individual projects will be assigned.

542. Musical Theatre Production (1-3) I Advanced study and techniques of stage directing, including play analysis, director-actor communication and technical problems of movement, composition, picturization and blocking. 2R, 2S.

543. Writing for Stage and Screen (3-3) Preparation and analysis of short scripts for stage and motion pictures.

544. Artist Collaboration (2) I 

545. Artistic Collaboration (3) I Exploration of the creative process from script to stage and motion picture; the application of the Creative Collaboration process to the creation of original works.

546. Screen Acting Techniques (3) I Principles and techniques of various performance styles involved in acting for television and motion pictures; basic problems faced by the actor in the development of his/her own personal performance. 1R, 4S, 2P.


548. Advanced Stage Costume Construction II (3) II 1989-90 Advanced costume design; emphasis on research, line and color analysis, and realized projects. P, 429.

549. Acting V (3) I Intensive study of classical acting styles with emphasis on Shakespeare.
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 plant ecology, systematics and evolution; evolutionary theory; ecological and molecular genetics; environmental physiology; marine biology; animal behavior; population biology and community ecology; vertebrate biology and systematics; evolutionary morphology; and theoretical and mathematical biology. The department offers excellent collections of fish, amphibians, reptiles, birds, and mammals. An extensive herbarium is shared with the College of Agriculture. Field work is facilitated by a Biological Station at Puertomagdalena, Sonora, Mexico and by the availability of the Coronado Ranch in the Chiricahua Mountains, the Southwestern Research Station, Portal, Arizona, the Research Ranch, Elgin, Arizona, and the Desert Laboratory on Tumamoc Hill, Tucson, Arizona.

Applicants are required to furnish the department with completed departmental application forms, copies of scores on the Aptitude and Advanced (any discipline) tests of the Graduate Record Examination, copies of transcripts of all college work, copies of GRE scores (in addition to those required by the Graduate College), and three letters of recommendation from persons qualified to evaluate the applicant's scholastic potential. Applications should be submitted by January 15; admission is normally approved by March 15. Applicants are encouraged to seek external financial support from institutions such as the National Science Foundation and the Danforth Foundation. The department has made every effort to make financial aid in the form of teaching or research assistantships available.

Course work, while necessary, is no substitute for research. 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.

500a-500b. Advanced Population Biology (4-4) 500a: Conceptual basis of modern population ecology and genetics; evolution of life histories, strategies, community structure, biogeography, theoretical and theory of optimal behavior. P, 431 or 500b. 500b: Testing ecological theory in desert ecosystems. 3R, 3L. Field trips.


503R.* Biology of Animal Parasites (3) I (Identical with VSc. 503R)

503L.* Parasitology Laboratory (1) I (Identical with VSc. 503L)

505.* Aquatic Entomology (3) II 1990-91 (Identical with Ento. 505)

512, Insect Behavior (3) I 1989-90 (Identical with Ento. 512)


518a-518b. *Scientific Illustration/Photography (2.4-2.4) [Rpt.] Individual basic training in the execution of thesis drawings and photographs. 518a: Illustration. 518b: Photography. Consult department before enrollment. (Identical with Anth. 518a-518b)

519. Plant Ecology and Genotype and Genome Organization (3) I 1990-91 A rigorous, comprehensive survey of both the molecular and evolutionary details of genome organization. P, 320, year of calculus.

521.* Philosophy of the Biological Sciences (3) 1989-90 (Identical with Phil. 521)

523.* Cytogenetics (3) II Investigation into the structure, function, and evolution of chromosomes and their role in heredity and evolution. 2R, 3L. P, 320 (Identical with Gene. 523)

524. Theoretical Population Genetics (3) I Involves the study of modern population genetics developed from first principles, with emphasis on evolutionary implications and the historical development of ideas. P, 320, Math. 223, (Identical with Anth. 524 and Gene. 524)

525. Speciation (2) [Rpt.] II Mechanisms of evolution in the formation of races and species of animals and plants. P, 320. (Identical with Genet. 525)

528R.* Advanced Microbial Genetics (3) I (Identical with M.C.B. 528R)

528L.* Advanced Microbial Genetics Laboratory (2) I (Identical with M.C.B. 528L)

531.* Environmental Physiology (3) I 1989-90 Analysis and synthesis of recent studies of the physiological responses of animals to their environments. P, 468R.

532. Physiological Ecology (2) II 1989-90 Analysis and discussion of contemporary research on organismic function and its interface with ecology, replacing "black box" assumptions with understanding of capacities and constraints. P, 468R.

536. Population Ecology (4) [Rpt.] I Empirical and theoretical treatment of competition, exploitation, and mutualism within and between species, with emphasis on application of mathematical models to dynamics of ecological problems. Computer lab. 3R, 3L, P, 302, two semesters of calculus.

535. Evolution (3) I A balanced survey of the present-day concepts of the processes 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 geographic distribution of plants and animals. P, 182 or Geos. 225, (Identical with Geos. 538)

540L.* Oceanography Laboratory (2) 1990-91 Field and lab. investigations of the Gulf of California, with emphasis on research techniques important to biological oceanography. Weekend field trips. P, or CR, 540R

541.* Limnology (4) I (Identical with WSc. 541)

542.* Ichthyology (4) 1989-90 I Ecology, evolution and systematics of fishes, with field and lab. emphasis on Gulf of California and Arizona waters. Field trips. P, 182. (Identical with WSc. 542)

543.* Air Pollution in Marine Biology (2) [Rpt. I Analysis and discussion of current research in the marine biological sciences.

544.* Insect Ecology (3) I (Identical with Ento. 544)

550. Mathematical Population Dynamics (4) II Ecological population dynamics, demography and human epidemiology. Emphasis on mathematical models and techniques for data analysis with particular reference to dynamical systems and chaos. 3R, 3L. P, full calculus sequence, upper-level ecology course (302) or ordinary differential equations (Math. 254 or 255) (Identical with Math. 550)

556.* Comparative Vertebrate Anatomy (4) I Comparative anatomy of vertebrates with emphasis on vertebral column, bony structure and evolution. P, 320.

557.* Comparative Vertebrate Histology (4) 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.

558.* Comparative Physiology Laboratory (1) I Psychological measurement techniques in laboratory and field studies. P, CR, 558R.

559.* Comparative Physiology (3-4) Basic principles and concepts of physiology applied to humans. P, 304, Chem. 214b, 243b. (Identical with Tox. 559-560)


565a-565b.* Human Physiology Laboratory (1-1) Lab. for 564a-564b. P, CR, 464a-464b. (Identical with Tox. 565a-565b)


568L.* Comparative Physiology Laboratory (1) I Physiological measurement techniques in laboratory and field studies. P, CR, 568R.

568L.* Comparative Physiology Laboratory (1) I Physiological measurement techniques in laboratory and field studies. P, CR, 568R.

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 biology or plant sciences.

572.* Systematic Botany (4) II Evolutionary relationships of orders and families of spermatophytes; systems of classification, collection and identification of local flora. 2R, 6L.

573.* Legumes, Grasses, and Compositae (2) II Identification and classification of the three largest flowering plant families of the Southwest. 6L.

575.* Freshwater Algae (4) II 1989-90 Systematics, ecology, and evolution of planktonic and benthic species; field techniques and lab. culture. 2R, 6L. Field trips. P, 4 units of biology or plant sciences.

577.* Art of Scientific Discovery (3) I 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, 6L. Field trips.

582. Icthyology (4) 1989-90 I Ecology, evolution and systematics of fishes, with field and lab. emphasis on Gulf of California and Arizona waters. Field trips. P, 182. (Identical with WSc. 582)

583. *Herpetology (3) I Systematics, ecology, and evolution of the amphibians and reptiles. 2R, 6L. Field trips.

584.* Ornithology (4) II Field trips. Natural history of birds and its bearing upon the problems of animal behavior, distribution, and evolution.
587.* Animal Behavior (3) I Concepts and principles of evolution, development, causation and function of behavior, with emphasis on the adaptiveness of behavior; discussion and films. F, 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.S.F. 589).
590.* Quantitative Morphology (3) I 1990-91 Methods for studying form variation and diversification; size-shape relationships; theoretical morphology.
504. Production Economics (3) I (Identical with A.Ec. 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. Advanced degree credit available for nonmajors only. P, 501. I 501b: General equilibrium and welfare economics. P, 501a, 523, I 501c: Other selected topics. P, 501a, 523.
509.* Economic Anthropology (3) II (Identical with A.Ec. 509).
510. Agricultural Economics (3) I Microeconomic theory and applications. P, M.I.S. 400 or Math. 119 or 123. Advanced degree credit available for nonmajors only.
512. International Agricultural Economic Development (3) II (Identical with A.Ec. 512).
513. Agricultural Price and Marketing Analysis (3) II (Identical with A.Ec. 513).
513. Rational Choice Theory in Economics (3) II (Identical with A.Ec. 513).
514. Cost-Benefit Analysis (3) II (Identical with A.Ec. 514).
516. Statistical Methods for Predicting Economic Events (3) II (Identical with A.Ec. 516).
518.* Introduction to Econometrics (3) I Statistical methods in estimating and testing economic models; single and simultaneous equations; identification, forecasting, and problems caused by violating classical regression model assumptions. Advanced degree credit available for nonmajors only. P, 352, 520.
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.
525. 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.
Education (EDUC/EDA/EDP/ED/ HED/LRC/SER/TEE)

Education Building, Room 201
(602) 621-1461

The College of Education offers certain courses that are not directly affiliated with any of the academic divisions in the college. In many cases, these courses are college-wide requirements for various revised degree programs being considered for approval at the time the catalog was being edited. Since implementation of the revised programs is anticipated for the 1989 Fall semester, all current and prospective students should check with the Office of Student Services in the college or consult the appropriate division for information on current degree requirements.

Division of Educational Foundations and Administration

educational administration
- M.A./M.Ed./Ed.D./Ph.D.

educational psychology
- M.A./M.Ed./Ed.S./Ed.D./Ph.D.

foundations of education
- M.A./M.Ed./Ed.D./Ph.D.

Education (EDUC)

500. Disciplined Inquiry in Education (3) II S Introduction to research methods in education: analysis of research; writing of research reviews; applying research results in educational settings.

501. Foundations of Education (3) II S Schools and social institutions; political and social influences on education; nature of the education profession; reform and implementation in education.

502. Variations in Learners (3) II S Nature and extent of differences among learners, both among and within groups; causes and factors relating to variations in learners; implications for educational placement, curricular planning and program development.

589. Anthropology and Education (3) II (Identical with Pol. 589).

600. Quantitative/Inferential Methods in Education (4) II S Statistical knowledge for use in describing educational research data and relationships between sets of data; statistical relationships among various forms of educational research inquiry. P. 500.

601. Qualitative Methods in Education (3) II S Introduction to theory and methods of conducting research through extended participant observation in school or community settings; field work, ethnography, case study, qualitative methods. P. 500.

602. Research Design and Techniques in Education (3) II S In-depth explorations of various research paradigms in educational inquiry and their research designs; critical analysis of the structure and logic of various designs and techniques; preparation of research proposals. P. 600.

611. Comparative Education (3) II S Emphasis on comparative education methodology; analysis of selected national educational systems, with focus on sociocultural foundations; curriculum and instruction; administration; teacher education; contemporary trends and issues; implications for education in the United States.

612. History of Education in the United States (3) I I The historical development of western educational thought from its origins to the present.

614. History of Education (3) II S Development of American educational thought from its colonial origin to the present.

615. Educational Sociology (3) II 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/EDP/HED)


Associate Professor Harley D. Christiansen, Sarah M. Dinham, Joseph D. Gullo (Emeritus), Stanley Pogrow, Donal M. Sacken, Sheila Slaughter.

Assistant Professors Martin Ahumada, Sharon Conley, Marcello Medina, Gary Rhoades.

The division offers programs leading to the Master of Arts and Master of Education degrees with majors in educational administration, educational psychology, foundations of 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 majors in educational administration, educational psychology, foundations of education, and higher education. The Doctor of Philosophy degree is offered with majors in educational administration, educational psychology, foundations of education, and higher education.

Concentrations are available within graduate majors offered in the division. Concentrations in educational psychology include school psychology and learning and development. The major in higher education is offered through the Center for the Study of Higher Education, with concentrations in academic administration, student personnel service administration, and institutional research.

The division also offers certification in educational administration and school psychology. Students seeking institutional certification 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 full standing in a graduate degree program. However, applicants who have an undergraduate grade-point average of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) with at least 3.00 is required for admission to full standing in a graduate degree program. However, provisional admission may be considered for approval, with implementation of the 1989 Fall semester. All current and prospective students should check with the Office of Student Services in the College of Education or the Division of Educational Foundations and Administration for information regarding the status and requirements of all programs and degrees.

Educational Administration (EDA)
Education Building, Room 635
(602) 621-3327

660. Administration and the Educational Environment (3) I I S Introduction to educational administration; overview of administration within school contexts and larger societal environment; organizational and leadership theories.

661. Administration of Bilingual Education Programs (3) I I I Organizational 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 I S Evolution of modern educational law and the impact of federal and state funded educational programs and effective community participation.

663. Computer Applications in School Administration (3) I Techniques for using computers to make school administration more efficient; using computers to enhance the management of information. P, or CR, 660.


666. Theory and Behavior in School Organizations (3) I I I Perspectives on the nature of the individual in the school organization; nature of schools as organizations; development of individual-organizational relationships. P, 660.

667. Educational Governance and Collective Bargaining (3) I Theory and practice of collective bargaining; history of negotiations in the educational sector; impact of statutes and governing authority. P, 660, 662 or CR.

668. Curriculum Change (3) I Techniques for administrators to use in analyzing the quality of the curriculum in schools as well as the appropriateness of instructional techniques used to support the curriculum. P, or CR, 660.

669. School Finance (3) I I Historical background of the financing of public education in the United States; economic and financial principles; sources and distribution of funds for education; budgeting, accounting, and reporting. P, 660, 661 or CR.

670. School Business Management (3) I I I The general management of school business; administration and accounting of school funds; administration of purchasing and supplies; other business operations. P, or CR, 660.

673. Administrative Leadership (3) I Explores the leadership process in education, including the use of power and authority in relation to the assumptions of organizational and behavioral theories. P, 660, 661 or CR.

674. Law and Administrative Practice (3) I I I Theoretical and practical aspects 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.

681. The Principalship (3) I I I Functions and activities of building-level administrators, with emphasis on: instruction, student development, student assessment, and operational services. P, 693a and 15 units of educational administration, CR, 693b.

682. The Superintendent (3) I I I 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 (1-3) [Rpt./4 units, 2 units] P, 690. b. Advanced Educational Administration (4) [Rpt./8 units] III P, 693a and 15 units of educational administration, CR, 681 or CR.

694. Practicum a. Educational Administration (1-3) [Rpt./12 units] I I I b. Advanced Educational Administration (3-4) [Rpt./8 units] I I I Caper, 693a or CR.

695. Capstone a. Issues in Educational Administration (1-3) [Rpt./12 units] I I I b. Topics in Educational Administration (1-3) [Rpt./12 units] I I I Caper, 693a.

696. Seminar a. Problems in Educational Administration (1-3) [Rpt./12 units] I.

Educational Psychology (EDP)
Education Building, Room 602
(602) 621-7825

500. Life Span Development (3) I I I Dynamics of development, social integration and roles across the life span. Special emphasis on cognitive, emotional, and personality development with comparison to normative and deviant patterns and models. (Identical with F.S. 500)


503. Advanced Adolescent Development (3) I I I Major developmental issues within the adolescent years; emphasis on the importance and design of adolescent research. (Identical with F.S. 503)

510. Learning Theory in Education (3) I I I Major theories of learning and motivation; emphasis on relationships between theory and practice in the schools.

517. Classroom Application of Behavior Modification Techniques (3) I I I Application of behavior principles and techniques to promote learning and social development of school-related behavior. 2R, 3L, P or CR.

530. School Psychology (3) I I I Roles of the school psychologist; implementing programs in the public schools; legal and ethical issues in school psychology. 2R, 3L, P or CR.

541. Statistical Methods in Education (3) I I Descriptive, correlational, and inferential procedures for testing and analyzing school-related data. 2R, 3L, P or CR.

557. Design of Questionnaires and Scales (3) I I I Emphasis on theoretical and methodological issues related to the development of survey and rating scales, sampling procedures, and response bias.
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.

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

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 financing; input and output measures.

504. Language and Culture in Education (3) I I 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 I Analysis of reading and writing relationships: development, instruction, and evaluation.

506. Teaching of Reading (3) I I Study of methods and materials used in teaching reading.

509. Language Research Methodology in Education (3) I II Investigation of procedures for conducting literacy research; examples of methodology taken from educational and social research.

510. Reading, Writing and Texts: A Psychosociolinguistic Perspective (3) I I Readers and writers as users of language; reading and writing as language processes; what makes a text a text.

511. Language Acquisition and Development (3) I II 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, and how language development relates to oral language development.

512. Applied Linguistics in Education (3) I I The application of linguistics and sociolinguistics to education; the role of language in society, particularly in reading and writing, as well as to evaluate readers, applications to reading strategies and curriculum; focus on comprehensibility.

513. Children's Literature in the Classroom (3) I I Analysis and discussion of classic and contemporary children's literature of all genres, and its relationship to language, reading, and culture.

514. Multilingual Literacy and Literacy (3) I I Analyses the use of multilingual literature that fosters self-concept, acceptance, and a sense of identity to develop literacy, includes readings from the major categories of multilingual literature about Black, Native, Hispanic, and Asian American cultures.

535. Secondary School Reading in the Classroom (3) I I Procedures and strategies for improving reading skills needed for college courses.

536. Classroom Communications and Interaction (3) I I The role of classroom interaction in the classroom, analysis of both verbal and nonverbal uses of language.

537. Classroom Diagnosis and Instruction (3) I I Procedures for diagnosing reading and writing skills for pupils of below-average achievement level.

538. Teaching of Reading (3) I I Development of language in young children; focus on oral language and its relationship to emergent literacy, instructional strategies that build on language development, and how language development relates to oral language development.

539. Applied Linguistics in Education (3) I I The application of linguistics and sociolinguistics to education; the role of language in society, particularly in reading and writing, as well as to evaluate readers, applications to reading strategies and curriculum; focus on comprehensibility.

540. Children's Literature in the Classroom (3) I I Analysis and discussion of classic and contemporary children's literature of all genres, and its relationship to language, reading, and culture.

541. Multilingual Literacy and Literacy (3) I I Analyses the use of multilingual literature that fosters self-concept, acceptance, and a sense of identity to develop literacy, includes readings from the major categories of multilingual literature about Black, Native, Hispanic, and Asian American cultures.

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553. Multilingual Literacy and Literacy (3) I I Analyses the use of multilingual literature that fosters self-concept, acceptance, and a sense of identity to develop literacy, includes readings from the major categories of multilingual literature about Black, Native, Hispanic, and Asian American cultures.

595. Colloquium a. Issues in Language, Reading and Culture (3) I 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, and how language development relates to oral language development.

596. Colloquium a. Issues in Language, Reading and Culture (3) I 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, and how language development relates to oral language development.

597. Workshop a. Southern Arizona Writing Project (3-9) I I Workshop to improve writing skills in students.

598. Workshop a. Southern Arizona Writing Project (3-9) I I Workshop to improve writing skills in students.

599. Workshop a. Southern Arizona Writing Project (3-9) I I Workshop to improve writing skills in students.
632. Second Language Acquisition in Formal Contexts (3) (Identical with Engl. 613)
633. Curriculum, Instruction and Supervision in Language Arts (3) I II Organizational patterns of language arts curriculum; 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) Methodology appropriate for reading and writing to learn content; compatible organizational models; program implementation. P. 504, 505, 507 or 551 or CR.

636. Writing in Context (3) Approaches to improving writing skills; assessment of students' writing; influence of writing on the teaching and learning process. P. 508.

637. Reading Diagnostic Laboratory (3-6) [Rpt./6 units] I II Supervised practice in reading assessment; center for influencing reading achievement, evaluation, construction, and administration of assessment procedures; development of interview techniques. P. 507, 509.

638. Reading Instructional Laboratory (3-6) [Rpt./6 units] I II Supervised practice in teaching reading and writing; preparing, analyzing and critiquing special instructional programs for students. Open to majors only. P. 507, 557.

639. Written Language Development (3) I II Study of recent research in the writing and reading development of preschool and school-aged children; relationships between reading and writing development explored through student research; applications of research. 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./6] P. 15 graduate units including 504, 505.

653. Written Language Development (3) I II Study of recent research in the writing and reading development of preschool and school-aged children; relationships between reading and writing development explored through student research; applications of research. P. 505, 553.

750. Colloquium a. Theory and Research in Language, Reading and Culture (1-3) [Rpt./15 units] I II P. 570.

796. Seminar a. Research and Evaluation in Language, Reading and Culture (1-3) [Rpt./15 units] I II P. 570.

Special Education and Rehabilitation (SER) Education Building, Room 412 (602) 621-7822

Professors James C. Chaffan, Head, William C. Healey, Bob G. Johnson, Jeanne McRae McCarthy, Amos P. Sales
Associate Professors Shirin D. Antia, Candace S. Bos, Marilyn Jensen, C. June Maker, S. Margaret McCallum
Assistant Professors Nancy Eldridge, Anthony K. Van Reusen

The division offers a program leading to the Master of Science degree with a major in rehabilitation. The division also offers programs leading to the Master of Arts, Master of Education, and Educational Specialist with a major in special education. The Doctor of Education and Doctor of Philosophy degrees are offered with majors in rehabilitation and special education. Concentrations are available within graduate majors offered in the division. Concentrations in special education are behaviorally disordered, hearing impaired, early childhood handicapped, learning disabilities, mental retardation, multiple and severe handicapped, gifted visually handicapped, and special education administration. Concentrations in rehabilitation are general rehabilitation counseling, rehabilitation psychology, counseling the deaf, counseling the blind, transitional counseling, 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 a grade-point average of 2.50 to 2.99 may be admitted on a provisional basis. A master's degree (any field) is a prerequisite for admission to a specialist or doctoral program. Beyond these minimal requirements, applicants must also meet the specific admission requirements for all majors offered in the division.

At the time the catalog was being edited, revisions to many of the programs in the division were being considered for approval, with implementation anticipated for the 1989 Fall semester. All current and prospective students should check with the Office of Student Services in the College of Education or the Division of Professional Child (3)
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 children. P, 505, 507 a -507 b, and permission of instructor.

503. The Special Services in the Schools (3) I II Information to aid teachers in dealing with handicapped students and concerns in school settings with regard to PL 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. The Bilingual Exceptional Learner (3) I Provides a theoretical base and practical approach to the study of special needs of the bilingual exceptional child; basic premises of bilingual special education and the interface of the two fields.

505. Introduction to Learning Disabilities (3) I I Theories and history of programs for the learning disabled; etiology, characteristics, and early identification, career education. P. 405.

506. Issues in Learning Disabilities (3) II Current issues in learning disabilities, including the federal and state governmental programs. P. 505.

507a-507b. Methods for Diagnosing Specific Learning Disabilities (3-3) I Educational and psychological assessment of academic areas including reading, writing, and arithmetic; preparation of problem statements, and individualized educational plan. P. 405 or CR and permission of division.

508. Remediation of Learning Disabled Elementary Students (3) II Remediation of academic areas and cognitive processes involving perception, integration, and expression, with emphasis on strategies for planning and implementing instructional programs at the elementary level. P. 405, 507a-507b, and permission of division; CR 590 and 594.

510. Introduction to Severe Disabilities (3) I II History and philosophy of educational programs for the mentally retarded and other developmentally disabled; etiology, classification, and educational characteristics, with consideration of educational, social, and psychological problems.

511. Teaching Learning Disabled Adolescents (3) I Intervention alternatives for teaching learning disabled adolescents at the secondary level. Emphasis on current intervention methods and practices. P. 400.

513. Educating Students with Severe Disabilities (3) II Methods of developing age-appropriate and functional programming, integration, community-based instruction, and integrative source delivery for students who have moderate to profound retardation and other physical, sensory and behavior disorders. P. 410.

518. Nonoral Communication (3) I Rpt./3) Techniques for assessment and intervention of alternative communication skills other than speech for students with severe disabilities. Preverbal communication skills development for students with severe communication impairments. Augmentative communication aids.

520. Vision and Visual Functioning (3) I Anatomy and physiology of the eye; visual development, assessment and training; relating visual defects to learning and school experiences.

522. Orientation and Mobility of the Visually Handicapped (3) II Methods of teaching orientation and mobility skills to visually impaired and blind students. Emphasis on the school-aged child, with particular attention to concept development, orientation skills, pre-care skills, personal safety, and independent ambulation, including an introduction to long-cane techniques.

528a-528b. Tactile Communication (3-3) I Basic principles, methods and techniques of teaching Braille and other written language systems for students who are blind. P. 405.

523a. Coded English; idioms, receptive skills, development and functioning of hearing impaired individuals. I II Emphasis on teaching academic and nonacademic skills and on educating students with nonhandicapped peers. CR, 593; P. 420.

530. Education and Rehabilitation of Hearing Impaired Individuals (3) I Current and historical perspectives; educational and rehabilitative services; etiology; impact on family. P. 410.

531a-531b. Advanced Sign Language (3) I II Advanced principles, methods and techniques of American Sign Language. Emphasis on the school-aged child, with particular attention to concept development, orientation skills, pre-care skills, personal safety, and independent ambulation, including an introduction to long-cane techniques.

542. Speech Development and Assessment; Hearing Impaired (3) II Development of speech language and hearing skills; assessment of speech intelligibility, articulation, speech reading and auditory functioning of learning impaired children. P. 430.

533. Interpreting in Special Settings (1-12) I II Interpretation services for the hearing impaired in areas such as educational, legal, medical, oral and MLP interpreting.

534. Language Development for the Exceptional Child (3) I Pragmatic, semantic and syntactic aspects of language development in
535. Assessment of Bilingual Exceptional Learners (2) I Educational and psychological assessment of bilingual students with emphasis on informal and formal evaluation methods and procedures for special education, identification and educational planning. P, 507.

536. Teaching Bilingual Exceptional Learners (2) I 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) I Receptive and expressive language assessment; techniques of teaching language intervention and remediation for hearing impaired children and youth. P, 534.


540. Education of Gifted Children (3) I Issues in education of the gifted; discussion of definitions, characteristics, development, screening, identification, curriculum, teaching strategies, and program development.

541. Teaching the Gifted: Questioning Strategies (3) II Mastery of skills 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.

542. Teaching the Gifted: Productive Thinking Models (3) I Mastery of skills involved in developing productive 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.

543. Teaching the Gifted: Hierarchical Models (3) I 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.

550. *Introduction to Early Childhood Education for the Handicapped (3) I Focuses on the handicapping conditions impacting on pre-school children, programs available to serve them and critical issues in this rapidly evolving field. P, 450.

551. Methods of Teaching Preschool Handicapped (3) I Deals with competencies required to teach all categories of handicapped preschool children except deaf/blind. Field trips. P, 460.

552. Methods of Assessment for Preschool Handicapped Children (3) I 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.

553. Client Assessment in Rehabilitation (3) I II Exploration of the world of work; critical review of vocational choice theories; experiences in the use and interpretation of individual assessment techniques. P, 565 or CR; Ed.P. 458.

554. Principles of Rehabilitation (3) I Principles underlying rehabilitation programs and interdisciplinary relationships of agencies engaged in rehabilitation services.

555. Administration of Special Education Programs (3) I II Practical aspects of organizing, planning, operating special education programs, problems of public relations, personnel, case finding, evaluation, placement, and records. P, consultation before enrollment.

556. 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.

557. Policy Analysis in Special Education (3) I II Practical aspects of policy analysis and development in schools and other social agencies which serve the handicapped and the gifted.

558. Medical Aspects of Disability (3) I II (Identical with L.R.C. 595b) Specific types of exceptional individual, psychological and educational implications and practices. Field trips, class discussions and seminars. P, 400. Screening, identification, and education in each category of the exceptionality to be arranged in the division office.

559. Psychosocial Aspects of Disability (3) I II (Identical with L.R.C. 595b) I II Exploration of the psychological and sociological aspects of disability; analysis of somatopsychology, psychosomatics, and social psychology.

560. Principles and Practices of Vocational Rehabilitation (3) I II Understanding work skills and labor market conditions; process of vocational evaluation of rehabilitation clientele; collecting and synthesizing evaluation data and writing meaningful reports.

561. 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.

562. Problems of Drug Abuse (3) I II Survey course for teachers, counselors, and agency workers concerned with drug abuse; examination of community, cultural, and educational implications and practices.

563. Vocational Planning and Placement (3) I II Problems of physical, mental, social, and emotional disability, as they relate to the formulation of a rehabilitation plan; exploration of the various sources of occupational and career choice information, job placement and development. P, 565, 580, 563 or CR.

564. Psychosocial Assessment of the Deaf Person (3) I II Selection, administration, and field test interpretation of various psychosocial evaluation instruments used with deaf persons. P, Ed.P 673, 674a.


566. Professional Problems in Rehabilitation Psychology (3) III 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.


568. Applied Research with Exceptional Learners (3) I II Review of principles and practices underlying applied research with exceptional learners; practice in preparation of research proposals; conduct of research emphasized.

569. Internship (1-2) II NOTE: Special sections in each concentration to be arranged in the division office.

570. Counseling the Gifted (1-6) IIOpen to majors only. b. Communication Development for Hearing Impaired Children (1-6) I P, 532, CR 593. c. Teaching the Gifted (1-6) [Rpt./9 units] II P, 440, 541, 542, 543.


572. Recent Advances in Special Education and Rehabilitation (3) I III b. Behavioral Disorders (3) I Open to majors only.

573. Group Processes (3) I III a. Giftedness and Creativity (3) II [Rpt./9 units]

574. Workshop in Creativity and Giftedness (3) II [Rpt./9 units]


576. Rehabilitation Administration (3) I II h. Rehabilitation Administration (3) I II i. Rehabilitation of the Deaf (3) I II j. Diagnosis in Rehabilitation Psychology (3) II

577. Teaching and Teacher Education (TTE) Education Building, Room 735 (602) 621-1602


The division offers advanced programs leading to the Master of Education, Master of Arts, Master of Teaching, Educational Specialist, Doctor of Education, and Doctor of Philosophy degrees with majors in educational administration and supervision and a variety of concentrations leading to the Master of Education degree with a variety of majors relevant to secondary school teaching. Also, the division offers the Master of Arts and the Master of Education with a major in educational media. 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 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 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 master’s programs in the division. Prospective students should check with the Office of Student Services in the College of Education or the Division of Teaching and Teacher Education for information regarding the status and requirements of all programs and degrees.

514. *Teaching of Modern Languages (3) III Specific methods, objectives, organization of subject matter and evaluation in modern languages. (Identical with Fre. 514 and Span. 514) *May be convened with 400-level course.

515. Observation and Supervision of Student and In-Service Teachers (3) II S Research-based strategies to supervise and critique teaching events, and to determine positive ways of thinking and acting in classrooms.

517. Preparation of Instructional Materials (3) II Study of techniques used in the development of instructional materials and processes. P 417. (Identical with U.S. 517)

518. Research Trends in Instructional Technology (3) II Past, present and future research on and trends in instructional technology used in K-12 classrooms.

519. Design of Instructional Media (3) II Principles of instructional design and development, including systems approaches, module development, and integration of media. P. 417.

520. The School Curriculum: Mathematics (3) II S Elementary and secondary mathematics curricula in terms of their aims and processes, instructional methods and assessment. These mathematics curricula are placed within a historical perspective and are examined from a theoretical and research base. P. 324 or 338h.

521. The School Curriculum: Mathematics (3) II S Elementary and secondary mathematics curricula in terms of their aims and processes, instructional methods and assessment. These mathematics curricula are placed within a historical perspective and are examined from a theoretical and research base. P. 324 or 338h.

522. The School Curriculum: Social Studies (3) II S Elementary and secondary social studies curricula in terms of their aims and 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. 324 or 338h.


525. Curriculum Issues and Practices: Social Studies (3) I S Current issues in social studies education and their application to classroom instructional practices and procedures. Topics selected based upon recent concerns and developments. P. 324 or 338h.

526. Investigations in Early Childhood Education (3) I 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 S Contempory 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 S An analysis of concepts, research findings, and effective practices for organizing and managing classrooms. Experiences in solving management problems provided. P. 324 or 338h.

532. Mathematics Diagnosis and Remediation (3) I S The nature and causes of student’s difficulties in mathematics, diagnostic techniques, and the development of prescriptive procedures of remedial instruction in mathematics. P. 326.

536. Alternatives in the Secondary Classroom (3) II S Theoretical bases, methods and strategies for delivering instruction in secondary classrooms are examined, discussed and applied.

537. Values in Teaching (3) I 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 combatting inequities.

538. Recent Research on Teaching and Schooling (3) 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) II S History, purposes, curriculum, instructional organization, and classroom processes for middle/junior high schools.

545. Curriculum Theory and Policy (3) I S A survey of theoretical frameworks in curriculums; the processes of content representation and enactment; planning evaluation, and change; analysis of curriculum policy.

597. Workshop I S Print Media Video in the Classroom (3) I j. Print Media in the Classroom (1-3) I S P. Ed.P. 301 or 310.

610. Applied Curriculum Theory (3) II S The theoretical principles, and organization of curriculum construction are discussed, evaluated and applied. P. 545.

612. Staff Development (3) I S Concept, context, content, processes and evaluation models of staff development as enacted in school settings.


635. Policy Analysis in Teaching and Teacher Education (3) I S II S Examination of policy development and enactment related to teaching/teacher education at local, state, and national levels, as well as methods and approaches to policy analysis. P. 539 and Educ. 500.

642. Middle-Level Curricular Process (3) I S Examination of procedures for curriculum/ instructional development, implementation, improvement and evaluation at the middle school level. P. 542.


697. Seminar (2-8) I S Research on Teaching (3) I S P. 539, 545 and Educ. 500.

Educational Administration (See Education)

Educational Foundations and Administration (See Education)

Educational Media (See Teaching and Teacher Education under Education)

Educational Psychology (See Educational Foundations and Administration under Education)

Electrical and Computer Engineering (ECE)

ECE Building, Room 230 (602) 621-2434


Assistant Professors Randall K. Bahr, Andreas Cangellaris, Raymond K. Kostuk (Optical Sciences), Syl-Yen Kuo, Ahmed Louni, Abhijit Mahalanobis, Michael W. Marcellin, Jerzy R. Rozenblit, William H. Sanders, Ronald D. Schrimpf, Hal S. Tharp

The department offers programs leading to the Master of Science and the Doctor of Philosophy degree, both in a major in electrical engineering. For information regarding the clinical engineering option, please see the College of Engineering section of this catalog.

Each applicant is required to submit scores on the Graduate Record Examination taken within the last five years. In addition, applicants for the Ph.D. program will be required to submit a detailed statement of professional goals, and three letters of recommendation.

For the Master of Science degree, the required thirty units must include at least fifteen units (other than the thesis) in the major field, and no more than nine of these may be dual numbered. Six units taken in another depart-
501. Linear Systems Theory (3) I Mathematical descriptions of linear systems, state-variables 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. Rules of transducers, operational amplifiers and instrument systems, with emphasis on biomedical applications; lab, experiments with transducers, amplifiers, comparators, and simple real devices. 2R. Engineering of wide bandwidth.

517. Clinical Engineering (3) II Activities and responsibilities of clinical engineers; hospital facilities, medical equipment specifications and control, safety, management and health care. (Intended for M.S.E. A.A.S.E.)

522. Active and Passive Filter Design (3) II Methods for realizing Butterworth, Chebyshev, Thomson and Elliptic filters; verification and testing of realizations.

523. Network Theory (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. 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.


531. Image Processing Laboratory (3) I Introduction to hardware and software used in image processing; image sampling and display systems, principles and applications; image processing software for image enhancement and information extraction; applied problems in natural resources, remote sensing. 3R, 3L. (Identical with Opt. 531)

532. Computer Vision (3) II Computer pattern recognition and scene analysis. Theory, algorithms, and applications of computer vision and artificial intelligence. P. 531, 533. (Identical with Opt. 532)

533. Image Processing: Devices, Systems and Applications (3) II 1989-90 Image formation; resolution; noise; linear processing; display; discrete images, sampling, coding; motion and hidden code; nonlinear computational processing; coherent processing; P. 502 or background in theory of linear systems. (Identical with Opt. 533)

535. Electrical and Optical Properties of Semiconducting Materials (3) I (Identical with M.S.E. 534)


536*. Introduction to Coding Techniques (3) II Error-correcting codes used in modern digital communication systems, with emphasis on hardware implementations and performance on real channels. P. Stat. 361.

538. Algebraic Coding Theory (3) II 1989-90 (Identical with Math. 539)


542*. Digital Control Systems Design (3) II Modeling, analysis, and design of digital control systems; A/D and D/A conversions, Z-transforms, time and frequency domain representations, stability, microprocessor-based designs. P. 501.


545. Decentralized Control and Large-Scale Systems (3) II 1990-91 Introduction to largescale systems, definitions and special problems of distributed parameter systems, decentralization of control and information, hierarchical and multi-level controllers. P. 501.

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


552. Electronic Devices I (3) II Ohmic contacts, Schottky barriers, diodes, static and dynamic, MESFETS, JFETS, BJTs, MOSFETS; structures, terminal behavior and frequency response, modeling. P. 552.

553. Linear Circuit Design (3) I Design of discrete and integrated solid-state circuits for small-signal applications; flow graph analysis; DC operational and wide-band amplifier design; power amplifier design.

554. Electronic Packaging Principles (3) II Introduction to problems encountered at all levels of packaging: thermal, mechanical, electrical, reliability, materials and systems integration. P. 554b: Laboratory. Implementation of design from 553a, mask-making, process calibration, evaluation of monitor structures, processing, packaging, and testing of chips.


556. Knowledge-Based System Design (3) II Computer-aided design software for constructing computer-aided engineering environments. To support engineering design. The framework will employ methods of artificial intelligence, theory of modeling, and simulation techniques. Term project and/or examination. P. 556. (Identical with C.S.C. 556).
578a-578b. Data Communications Networks (3-3) I 578a: Introduction to ISO open systems interconnection reference model, characteristic of baseband and broadband networks, physical layer functions and protocols, IEEE 802.3, 4, 5 operation. 578b: Computer network performance evaluation, OSI network transport session layers, network standards, network software services, gateways, and networking simulation platforms.


581. Electromagnetic Field Theory (3) II Methods used in solving electromagnetic problems of current importance such as appearing in IEEE transactions on microwave theory and techniques, antennas and propagation, and electromagnetic compatibility, and radio science. P. 502 or Math. 422b, E.C.E. 482 or Phys. 415b.

583. Remote Sensing Instrumentation and Techniques (3) II Development of instrumentation, measurement and signal processing techniques required for electromagnetic remote sensing applications with emphasis on atmospheric remote sensing, radar processing, and mathematical and computer simulation; applications to practical radar and communications problems. P. 581.

585. Radio Waves (3) II 1990-91 Geometrical ray tracing, diffraction and scattering, ground wave propagation, magneto-ionic theory, random media effects, topographic influences, satellite communications, and fiber optic transmission. P. 381.

586. Geo-Electromagnetism (3) I 1989-90 Earth resistivity principles, induced polarization, electromagnetic induction and loop-loop coupling, earth conduction effects in power systems, well logging, geogeometrics, magnetotellurics and tunnel transmission. P. 482; 502 or Math. 422b; Phys. 415b. (Identical with Geo. 586)

587. Plasma Etching (3) II 1990-91 Practical methodology of basic etch processes in silicon, silicon oxide and nitride, and aluminum. Plasma physics and computer simulation; familiarity with processing techniques, or consent department before enrolling.

589. Atmospheric Electricity (3) II 1989-90 (Identical with Atmo. 589)

615. Advanced Communication and Measurements (3) II Instrumentation and measurement systems; measurement errors, noise reduction and amplifiers; emphasis on biomedical technology; research project on lab computer 2R, 3L.

634. Electronic, Magnetic and Optical Materials (3) II (Identical with M.S.E. 634)

636. Information Theory and Coding (3) II 1990-91 Definition of a measure of information and study of its properties; introduction to channel capacity and error-free communications over noisy channels; encoding and decoding Shannon-Fano, arithmetic, and Lee-correction and error detecting codes for noisy binary channels. P. 503. (Identical with Math. 636)


597a-597b. Data Communications Networks (3-3) I 578a: Introduction to ISO open systems interconnection reference model, characteristic of baseband and broadband networks, physical layer functions and protocols, IEEE 802.3, 4, 5 operation. 578b: Computer network performance evaluation, OSI network transport session layers, network standards, network software services, gateways, and networking simulation platforms.


581. Electromagnetic Field Theory (3) II Methods used in solving electromagnetic problems of current importance such as appearing in IEEE transactions on microwave theory and techniques, antennas and propagation, and electromagnetic compatibility, and radio science. P. 502 or Math. 422b, E.C.E. 482 or Phys. 415b.

583. Remote Sensing Instrumentation and Techniques (3) II Development of instrumentation, measurement and signal processing techniques required for electromagnetic remote sensing applications with emphasis on atmospheric remote sensing, radar processing, and mathematical and computer simulation; applications to practical radar and communications problems. P. 581.

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related engineering and involves the use of the engineer's background and skills as a part of the total health care team. The option includes specific and elective course work, laboratories, a thesis project, and a nine- to twelve-month clinical engineering internship in a hospital.

The program is designed to encourage engineering study and research efforts directed toward society's energy needs. The scope of interest includes energy sources (fossil, geothermal, hydro, nuclear, and solar); systems to convert and transfer energy and power; efficient energy utilization; and environmental controls. Applied research and industrial interaction are stressed. The program is coordinated by a committee representing the departments in which the option is available.

**Engineering Mechanics**

(See Civil Engineering and Engineering Mechanics)

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**English (ENGL)**

Modern Languages Building, Room 445
(602) 621-1836


Assistant Professors: Douglas Adamson, Meg Lota Brown, Susan Derwin, Theresa Enos, Elizabeth Evans, Donna Johnson, Terry McMillan, Thomas Miller, Tenney Nathanson, Alice M. Seno (Emerita), Susan White, Lynda Zwingler

The department offers programs leading to the Master of Arts degree with a major in English or in English as a second language, the Master of Fine Arts degree with a major in creative writing, and the Doctor of Philosophy degree with a major in English or a major in English education.

**Degrees**

**Master of Arts (Major in English):** To be admissible, applicants must have completed the equivalent of the undergraduate major in English with a grade-point average of at least 3.50 in courses in English. Applicants must submit evidence of their preparation in English and advanced literature in English tests of the Graduate Record Examination and a short sample of their scholarly or critical writing. Applicants must also arrange to have the department receive three letters of recommendation. These materials should be addressed to the Director of Graduate Study of the Department of English.*

**Master of Arts (Major in English as a second language):** General Graduate Record Examinations, and Nuclear and Energy Engineering. The program is designed to encourage engineering study and research efforts directed toward society's energy needs. The scope of interest includes energy sources (fossil, geothermal, hydro, nuclear, and solar); systems to convert and transfer energy and power; efficient energy utilization; and environmental controls. Applied research and industrial interaction are stressed. The program is coordinated by a committee representing the departments in which the option is available.

**Doctor of Philosophy:** The admission requirements for this degree program are the same as those set forth for the Master of Arts with a major in English. In addition, at least 50 hours of 500-level work (beyond the requirements for the Master of Arts degree) must be completed in addition to the dissertation. All students must pass an examination equivalent to the final examination for the Master of Arts degree with high pass performance. All students for the Ph.D. degree are required to pass the Ph.D. preliminary examination and write a dissertation acceptable to the Department of English.*

*Details of specific departmental requirements for the various degree programs should be obtained from the Director of Graduate Study of the Department of English.

**501.** Advanced Nonfiction Writing (1-4) [Rpt./2] I & II P. 301

**502.** Business Report Writing (3-5) I & II Study and development of written reports in business. 503a. Introduction to Comparative Literature and Literary Theory (3) I (Identical with C.P.L.T. 503a)

**505.** History of the English Language (3) I & II The evolution of English sounds, inflections, and vocabulary from earliest times to the present, with attention to historical conditions. (Identical with Ger. 505)

**506.** Modern Grammar and Usage (3) I Current American English structure according to major types of grammar and current American English usage, both with reference to standard British English.

**508.** English as a Second Language in Bilingual Education (3) I & II Designed for teaching assistants in English.

**510.** Teaching of Composition (3) I & II Theory and practice of teaching writing in secondary schools and colleges. P. 306

**511.** Teaching Literature (3) I & II Theory and practice of teaching literature, with intensive study of genres and works commonly taught in secondary schools. P. nine units of literature.

**512.** Teaching of the English Language (3) I & II Theory and practice of teaching various aspects of language in the secondary schools. P. 405/505, 406/506

**513a.** Writing in English (1-4) [Rpt.] I & II Explores prose through discussing and writing of forms and types, research paper. P. 309

**515a-515b.** History of Criticism (3-3) 515a: Plato through the 19th century. 515b: Modern criticism

**516a-516b.** Theories of Linguistic Structure (3-3) 516a: The American tradition in linguistics. 516b: The European tradition in linguistics. 516a is not prerequisite to 516b.

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**English 591.** Preceptorship (Identical with Ger. 585i)

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**520.** History of the German Language (3) I & II (Identical with Ger. 520)

**525.** Beowulf (3) I (Identical with Ger. 525)

**526.** Advanced Studies in Chaucer (3) I & II

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

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

**531.** Advanced Studies in Shakespeare (3) I & II

**533.** Studies in the Renaissance (3) I & II

**534.** Studies in the Enlightenment (3) I & II

**541.** Studies in the Restoration and Eighteenth Century (3) I & II

**547.** Introduction to TESL: An Overview (2) I & II 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, folklore, riddle, proverb, jokes, folksong, ballad, etc. 549b: Non-verbal Folklore: custom, belief, folk art and craft, food, medicine, dress, festal, and drama. (Identical with A.In.S. 549a-549b and Phil. 549a-549b)

**555a-555b.** Studies in Nineteenth-Century British Literature (3-3) 555a: The Romantics. 555b: The Victorians

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

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

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

**566a-566b.** Studies in 20th-Century American Literature (3-3) 566a: Modern American literature. 566b: Contemporary American literature

**577.** Ethnic Literature

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**English 585.** Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] I & II (Identical with Ger. 585)

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**591.** Preceptorship

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**595.** Colloquium

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**596.** Seminar

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**598.** Seminar

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**599.** Seminar

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**600.** Seminar

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**601.** Seminar

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**602.** Seminar
EIGHTH YEAR (ENVIRONMENT AND BEHAVIOR)

Position on Education and Development

The Department of Mathematics and Science offers programs leading to the Master of Science and Doctor of Philosophy degrees in biology and chemistry. Disciplinary specializations are available in agricultural entomology, aquatic entomology, ornithology, and environmental biology. Biologists working in this area need an understanding of the processes occurring within and between ecosystems, including the role of insects as model systems. Graduate students should consult their department chairperson for information on the requirements for the master's degree.

The doctoral program requires, in addition to the requirements for the master's degree, courses in biochemistry, computer programming, advanced statistics, and the equivalent of one semester of teaching experience.

503R. Biology of Animal Parasites (3) I


543. Insect Neurobiology (3) III Principles of neurophysiology, development and function and development of the insect nervous system. Establish basic concepts in neurobiology and functional anatomy of insects as a model system. 2R, 3L. Field trips. P, Ecol. 181, 182 or two courses in biochemistry. Tobin.

544. Insect Ecology (3) I Determinants of population size and distribution, including processes occurring within and between ecosystems, abiotic factors. 2R, 3L. Field trips. P, one course in entomology or Ecol. 182. (Identical with Ecol. 544). Moran.

552. Medical-Veterinary Entomology (4) I, II Survey of arthropods of public health and veterinary importance, with emphasis on transmission dynamics of pathogens, biomarkers of vector populations, and current control concepts. 3R, 3L. P, 201; parasitology recommended. (Identical with Visc. 552).

568. Agricultural Entomology (3) I Principles underlying the management of arthropods in agricultural systems, the population ecology of pests and weeds, and the application of agricultural and rangeland entomology. P, 444 and 468. Watson.


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


696. Seminar (1) [Rpt./6] I, II

Environment and Behavior (ENV)

Psychology, Building, Room 517 (602) 621-7430

Committee on Environment and Behavior (Graduate)

Professors Robert Bechtel, Chairperson (Psychology), Charles Albanese (Architecture), Terry Daniel (Psychology), William Havens (Renewable Natural Resources), William Itelson (Psychology), David King (Renewable Natural Resources), Kirby Lockard (Architecture), William Rathe (Anthropology), Thomas F. Saarinen (Geography), Lawrence Wheeler (Psychology), Ervin H. Zube (Renewable Natural Resources), Associate Professors Dennis Doxtater (Architecture), William Shaw (Renewable Natural Resources), Assistant Professor Robert Itami (Renewable Natural Resources).

The Committee on Environment and Behavior functions to coordinate and further develop study of the relationship between physical setting and human activities. This multidisciplinary group of teachers and researchers will assist students interested in combining an environment and behavior emphasis into majors such as psychology, architecture, landscape architecture, interior design, geography, renewable natural resources, political science, and water resources administration. Interested students should consult their department advisors and appropriate members of the Committee on Environment and Behavior.

While no graduate major is offered, the committee does offer a doctoral minor. A minimum of fifteen units from environment and behavior courses approved by the committee is required.

Current information on studies in environment and behavior can be obtained from the Chairperson, Committee on Environment and Behavior, Department of Psychology. Courses identified as having content which deals specifically with environment and behavior include: Academic Professors: F. Art 434; Geol. 275, 360, 507, 561, 563; Idis. 596; L.Ar. 533, 595a; L.R. 470; Pol. 581; Psych. 371, 521a-521b, 527; R.N.R. 595c.

Ethnic Studies

(See American Indian Studies)

Family and Consumer Resources

(FCR/CT/CS/COUN/FS/HEE/ID)

FCR Building, Room 205 (602) 621-1075

Professors Victor A. Christopherson, Acting Director, Oscar C. Christensen, Kathryn L. H. Debs, Mary E. Dobb, Judith R. Kearns, Amy Jean Knorr (Emeritus), Doris E. Manning (Emeritus), Naomi A. Reich, Robert R. Rice, Carl A. Ridley, George B. Sproles, Mary Adele Wood (Emeritus).

Assistant Professors Richard L. Erickson, Donna R. Iams, Roger M. Kramer, Philip J. Lauver, Mary H. Marion, Betty J. Newlon,
The School of Family and Consumer Resources offers programs leading to the following graduate degrees:

- Master of Science with a major in family and consumer resources and concentrations in clothing and textiles, family economics/consumer resource management, counseling and guidance, home economics education, interior design, and family economics/consumer resource management.
- Master of Education with a major in family and consumer resources.
- Master of Arts with a major in counseling and guidance
- Doctor of Philosophy with a major in family and consumer resources.

All applicants are required to submit scores on the aptitude test of the Graduate Record Examination, three letters of reference, and a statement of academic and professional goals. Degree requirements are given in the notes under each program area below.

**Program Areas:**

**Clothing and Textiles**

- Consumer Studies
- Counseling and Guidance
- Family Studies
- Home Economics Education
- Interior Design

**Programs**

**Clothing and Textiles:** For the Master of Science degree with a major in family and consumer resources, a concentration in apparel and textiles is available in clothing and textiles. Students are required to complete 34 units including four to six units for the thesis. This program prepares students for employment in teaching at the secondary school, community college, or university level, and for professional and educational or testing and research positions with industrial and commercial companies.

**Consumer Studies:** A program leading to the Master of Science degree with a concentration in family economics/consumer resource management is available. Requirements to be included in the graduate study are: 30 units in the major and a minor in another area, including statistics and research methods plus four to six units for the thesis. Because of the interdisciplinary nature of the program, allied subjects such as economics, psychology and sociology may be selected to give the desired emphasis. This program prepares students for a variety of career opportunities depending on the selected emphasis.

**Counseling and Guidance:** The division offers programs in the Master of Arts in Family Counseling and Guidance, Master of Arts in Family Guidance, Master of Arts in Family Counseling, and Master of Arts in Family Guidance. 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 department. Master's degree applicants must submit a personal data blank, a candidate's statement, letters of recommendations, and scores of the Graduate Record Examination. All application materials for fall admission must be received by March 1.

Individual master's programs will be planned with and approved by an advisor. These may vary both in course work and in total units, depending upon the area of concentration and upon past experience and training.

**Family Studies:** Family Studies involves the scientific study of family 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, or a combination. A total of thirty units is required. These programs prepare students for 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 consent of the student's graduate committee and the director of the School, after consideration of the student's preparation and professional objectives.

**Interior Design:** The Interior Design graduate program is designed primarily to accommodate outstanding graduates of interior design or design-related programs. It is flexible in concept to meet the needs and interests of students who desire advanced, specialized research in interior design and related fields.

For admission consideration, applicants must have completed with a grade-point average of 3.0 or better all undergraduate work or provide documentation of substantially equivalent to the Interior Design program at the University of Arizona. Candidates without a design background will be required to complete a minimum undergraduate course work 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 applying; (2) a resume including a detailed record of professional work experience in interior design or related fields; (3) a slide portfolio of creative studio work including complete interior design projects, and related work in graphic design, art history, history and/or professional references. No application will be considered until all of these items are 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 designed to meet the needs of the master's and doctoral students, additional units may be required. The graduate study program will be planned by the student in consultation with the designated major professor.

**Family and Consumer Resources (FCR)**

565.1 Women in International Development (3) [Identical with Anth. 565]

695. Seminar

z. Family and Consumer Resources (1-3)

**Clothing and Textiles (CT)**

N. Reich, Program Leader

534.1 The Fashion Industry (3) II Operations of the wholesale to retail channel, and development of retail strategy by different types of retail outlets. P, C.T. 304, Mktg. 361.

544.1 Dimensions of Clothing Behavior (3) II Analysis of psychological, social, cultural, historical, economic and aesthetic dimensions of clothing reported in literature. P, 145, Soc. 100, Pysc. 101, Econ. 201a.

545.1 Clothing for Special Needs (3) II Clothing and accessories for special needs; based upon research. (Identical with Gero. 545)

554.1 New Developments in the Textile Field (3) II Fabric finishes, new fiber development, textured yarns and fabric use and care problems. P, 284R.

564.1 Aspects of Clothing Design (3) II Projects in the analysis and manipulation of design media to produce garments to meet selected needs and populations. 1R, 6L. P, 145, 344.

**Consumer Studies (CS)**

M. Wilhem, Program Leader


536.1 Economics of Aging (3) II Economic issues as they affect the aging individual, family and society; economic demographics, consumer problems, and different financial planning. (Identical with Gero. 536)

546.1 Consumer Economics (3) II Study and application of consumer economics under existing market conditions. (Identical with A.Ec. 546)

556.1 Family Economics (3) II Analysis of the family as an economic-decision-making unit within the larger economic system. P, Econ. 201b.

**Counseling and Guidance (COUN)**

R. Erickson, Program Leader

503.1 Principles of Adlerian Psychology (3) II Techniques for the study of human behavior; implications for improving adult-child relationships. Emphasis on Adlerian principles.

521.1 Techniques of Interviewing (3) II Types and functions, process, and application of the interview in various settings.

549. Counseling and Guidance Laboratory
Assistant Professors Prabir Datta, William V. Harlow III, John D. Schatzberg, Howard S. Stern

The department offers programs leading to the Master of Science degree with a major in finance. Concentrations are available in finance or real estate. The department also participates in the programs leading to the Master of Business Administration and the Doctor of Philosophy degrees with a major in business administration. For information concerning these degrees see Requirements for Master's Degree/Master of Business Administration and the headnotes of Business Administration elsewhere in this catalog.

For admission, the applicant is expected to have completed undergraduate work in managerial accounting, economics, finance, marketing, organizational behavior, production, business policy, statistics, and mathematics through calculus (Math. 119 and 123). A score on the Graduate Management Admissions Test in the sixtieth percentile or above and an academic average of approximately "B" or better are required for admission consideration.

The program for the Master of Science degree with a major in finance includes a minimum of 30 units at the 500 level and either a thesis or a research report,

511. Managerial Finance (3) I II Integration of the basic principles and underlying theory of finance, with emphasis on analytical financial management of business firms and other organizations. Students with credit in Fin. 412 should take Fin. 512. Open only to students admitted to a BPA graduate program. P, Acct. 550.

512. Advanced Corporation Finance (3) II Financial theory applied to capital structure, investment decisions; corporate valuation; and corporate financial policies. P, Fin. 412 or 511.


537. Finance for New Ventures (3) I Value maximization; simulation of value distribution; sources of venture capital; timing of initial public offering; new venture ownership structure. Open only to students in the entrepreneurship program. P, Fin. 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 (Identical with Acct. 569)


695. Colloquium a. Research and Finance (3) [Rpt./4] I II
b. Investments (3) [Rpt./1] I II
Committee on Genetics (Graduate)

Professors Margaret G. Kidwell (Ecology and Evolutionary Biology), Chairperson, Harrison Bernstein (Microbiology and Immunology), Conrad Istock (Ecology and Evolutionary Biology), Robert McDaniel (Plant Sciences), Neil Mendelson (Molecular and Cellular Biology), Richard E. Michod (Ecology and Evolutionary Biology), David Mount (Molecular and Cellular Biology), Nobuyoshi Shimizu (Molecular and Cellular Biology), Samuel Ward (Molecular and Cellular Biology). Associate Professors Danny L. Brower (Molecular and Cellular Biology), David Rowe (Family and Consumer Resources), Jeffrey Trent (Radiation Oncology). Assistant Professors Sue K. DeNise (Animal Science), Dennis Ray (Plant Sciences), Steven Smith (Plant Sciences), J. Bruce Walsh (Ecology and Evolutionary Biology).

Geneticists from various departments comprise the interdepartmental Committee on Genetics, which offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in genetics. The areas of study emphasized by the committee are molecular and cellular genetics, cytochemistry, and population genetics. Research opportunities include bacterial and bacteriophage genetics, gene regulation, developmental plant genetics, plant and animal cytogenetics, somatic cell genetics, cancer and clinical genetics, 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 1990-91
(Identical with An.S. 513)
The climate, landforms, hydrology, soils and environmental systems and changing patterns of regional contrasts, with emphasis on tropical culture in the major natural and cultural regions of Mexico, Central America, and West Indies. Pederson

Pederson

South America (3) I Physical and cultural bases of South America's geographic patterns, with emphasis on human settlement and problems of resource development. Pederson

Pederson

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

Pederson

513.* Introduction to Geographic Information Systems (3) I (Identical with R.N.R. 517, but not for both. (Identical with Ping. 561) Mulligan

pederson

514.* Site Planning (2) I (Identical with Arch. 544)

pederson

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 Ping. 550) Mann

pederson

551.* Location Analysis (3) II Industrial location theory and location factors, consumer behavior and market areas, geography of economic impacts, location of public facilities. (Identical with Ping. 553) Mulligan

pederson

557.* Statistical Techniques in Geography 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 Ping. 557)

pederson

561. Resource Management (3) I Examination and critical analysis of social and behavioral science aspects of resource management, with special emphasis on factors affecting decision making. (Identical with Ping. 561) Saarinen

pederson

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 Ping. 563) Saarinen

pederson

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

pederson

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. Altshul

pederson

567. Geographical Analysis of Population (3) I Population distribution and change; practical methods of demographic analysis, migration business, and planning applications. Plan

pederson

571.* Problems in Regional Development (3) I 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) Pederson

pederson

581.* Computer Cartography (3) I 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)

pederson

583.* Geographic Applications of Remote Sensing (3) II Use of aircraft and satellite imagery for monitoring landforms, soils, vegetation and water bodies, with emphasis on problems of land-use planning, resource management and related topics. 2R. FL. Field trip. P. two units of remote sensing or equivalent experience. (Identical with Ping. 583) Marsh

pederson

596. Seminar g. Urban Geography (3) [Rpt./9 units] III k. Risk and Society (3) I (Identical with W.R.A. 596K, which is home) u. Environmentalism—Behavior-Design (3) I (Identical with Idis. 596u, which is home)

pederson

597. Workshop a. Geography for Teachers (3) S "May be convened with 400-level course."

pederson

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

pederson

608. Planning Law (3) II Land-use controls, the law of zoning, exclusionary zoning, restrictive covenants, comprehensive plan, environmental protection, eminent domain, nuisance. (Identical with Ping. 608)

pederson

609. Policy Problems in Structure and Change (3) II (Identical with M.A.P. 609)

pederson

611. Projects in Regional Planning (1-5) [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)

pederson

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) Reeves

pederson

659. Growth Controls (3) II Current legal and planning techniques to regulate the rate of growth, the sequence of growth, and the eventual total size of towns, regions, and states; concentration on case studies. (Identical with Law 659 and Ping. 659)

pederson

689. History of Geographic Thought (3) II History of geographic philosophy and methodology. P. 15 units of geography. Pederson

pederson

Geosciences (GEOS)

Gould-Simpson Building, Room 208 (602) 621-6024

geosciences


geosciences

Assistant Professors Lisa J. Graumlich, Thomas M. Richardson, Terry C. Wallace

geosciences

Assistant Professors Joanne M. Anovitz, Andrew S. Cohen, George E. Gehreis, Roy A. Johnson, Joaquin Ruiz, Eleanour A. Snow

geosciences

Laboratory of Tree Ring Research

West Stadium, Room 109

(602) 621-2191

geosciences

Professors Malcolm K. Hughes, Director, Bryant Bannister (Emeritus), Jeffrey S. Dean, Harold C. Fritts, William J. Robinson, Charles W. Stockton, Marvin A. Stokes (Emeritus)

geosciences

Assistant Professors Andrew J. Graumlich, Thomas M. Richardson, Frank W. Telewski

geosciences

The department offers graduate studies leading to the Master of Science and the Doctor of Philosophy degrees with a major in geosciences. Applicants for graduate degrees must have completed the baccalaureate with a major in geosciences or in an allied discipline. All applicants must submit 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 research experiences are vital to their professional growth and for those who develop strong research interests and abilities. 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. 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 are encouraged to pursue a specialization, or a major, within the department.
degree in geosciences should concentrate in one or more of the following areas:

- Economic Geology
- Structural Geology
- Geothermal ore deposits
- fluid inclusion studies
- sulfur isotope analysis
- alteration petrology/geochemistry
- plate tectonics and ore deposits
- mathematical theory of magma hydrothermal systems
- dynamics, NMR, and mass spectrometry theory
- 3R, 3L. Open to majors only. P, Chem. 103a-103b, Phys. 110, 116, 121 or 103a-103b and 180a-180b. Ruiz

### 506. Analytical Techniques in Geology

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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>506. Analytical Techniques in Geology</td>
<td>Strengths and limitations of methods and analysis of geologic material including XRF, XRD, Mineral Amino Acids and the Isotopes of Water, and Geochemistry of Kerogen, Amino Acids and the Maturity of Coal.</td>
</tr>
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</table>

### 507. Analytical Techniques in Geology

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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>507. Analytical Techniques in Geology</td>
<td>II Analytical techniques for major and trace elements in rocks, minerals, and fluids.</td>
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### 508. Mammalian Phylogeny and Evolution

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<th>Course</th>
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<tbody>
<tr>
<td>508. Mammalian Phylogeny and Evolution</td>
<td>II 1991-92 A study of the mammalian fossil record, with emphasis on taxonomy and morphological characters.</td>
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### 509a-509b. Petrology

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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>509a. Petrology</td>
<td>Environmental geology; geothermometry and kinetics of the evolution of rocks and minerals; thermal evolution of rocks; crustal evolution; petrology and evolution of the mantle; geochemistry of hydrothermal processes; organic geochemistry of kerogen, amino acids and the isotopes of carbon.</td>
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<tr>
<td>509b. Petrology</td>
<td>Introduction to the use of thermodynamics and kinetics in the study of petrogenetic processes.</td>
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### 510. Principles of Cosmochemistry

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<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>510. Principles of Cosmochemistry</td>
<td>I 1990-91 Introduction to the use of thermodynamic and kinetic principles to the study of the solar system.</td>
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### 511. Pressure-Temperature-Time Constraints on Rock Evolution

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<th>Description</th>
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<tbody>
<tr>
<td>511. Pressure-Temperature-Time Constraints on Rock Evolution</td>
<td>II 1990-91 Introduction to the use of thermodynamic and kinetic principles to the study of rock evolution.</td>
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### 512. Petrology of Sandstones

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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>512. Petrology of Sandstones</td>
<td>I Origin, deposition, and diagenesis of sandstones and other tectonic sedimentary rocks; classification in hand specimens, detrital grains, and thin mineralogy.</td>
</tr>
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### 516. Field Studies in Geophysics

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<th>Course</th>
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### 517. Sedimentary Basin Analysis

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<th>Course</th>
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<tbody>
<tr>
<td>517. Sedimentary Basin Analysis</td>
<td>I Stratigraphic sedimentological, paleogeographic, and paleoecological characters of sedimentary basins with attention to facies relations, depositional systems, and structural framework.</td>
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### 518. Advanced Mineralogy

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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>518. Advanced Mineralogy</td>
<td>I Structure and crystal chemistry of minerals, microstructural development, kinetics and mechanisms of mineral reactions, and the use of mineral chemistry to determine geologic history of rocks.</td>
</tr>
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### 519. Global Tectonic Processes

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<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>519. Global Tectonic Processes</td>
<td>II Plate tectonics; thermal properties and processes in the Earth; mechanical behavior of lithosphere and mantle; global gravity and geoid.</td>
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### 520. Meteorites

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<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>520. Meteorites</td>
<td>I 1990-91 I Advanced mineralogy processes. II Quality control of meteorite samples and computer models to represent the redistribution of thermal and mechanical energy around magma chambers.</td>
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### 521. Analysis of Regional Geologic Structure

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<th>Course</th>
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<tbody>
<tr>
<td>521. Analysis of Regional Geologic Structure</td>
<td>I Geodynamic 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. G. Gehrels</td>
</tr>
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### 522. Well Logging Interpretation

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<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>522. Well Logging Interpretation</td>
<td>II Analytical techniques for major and trace elements in rocks, minerals, and fluids.</td>
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### 525. Regional Tectonics

<table>
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<tr>
<th>Course</th>
<th>Description</th>
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<tbody>
<tr>
<td>525. Regional Tectonics</td>
<td>I 1990-91 Geodynamic and tectonic evolution of the North American Cordillera based on analysis of geologic, paleomagnetic, and paleobiogeographic constraints and tectonic models. Gehrts</td>
</tr>
</tbody>
</table>
Master of Education degree with a major in German. For information concerning this degree see the Master's Degree in Master of Education elsewhere in this catalog. Studies are available in the various areas of German language, literature, and culture in their more historical 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 16 acceptable units of upper-division, undergraduate course work in German.

Students working toward the Master of Arts degree must complete a minimum of 32 units of graduate course 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 and consultation with the departmental Graduate Committee. Students approved for the thesis option must complete the 24 unit course work requirement in addition to the thesis and departmental proficiency exam. No more than six units may be earned for writing the thesis; this admission for thesis 910.

The student must pass both a written and an oral comprehensive examination. Prior to and at the time of 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/week, no credit) S Rapid acquisition of reading proficiency in German. No prior knowledge of German is necessary. Proficiency certification obtained from this course fulfills graduate foreign language requirement in some departments. Consult department for information.

501. German Lyric Verse from the Reforma-
tion through Classicism (3) II 1990-91 Introduction to the major works of German lyric verse from the 16th through the 18th centuries. P, 6 units of upper-division German. Classen

502. German Lyric Verse from Romanticism to the Present (3) I 1989-90 Introduction to the major works of German lyric verse from the 19th century through the 20th century. P, 6 units of upper-division German. Richter

505. * History of the English Language (3) I II 1989-90 Readings and discussions of representative works from Old English (840) to modern English. P, 6 units of upper-division German. Richter

507. Goethe 1848 through Naturalism (3) I 1989-90 Readings of major prose and dramatic works of the second half of the 19th century, in German. P, 6 units of upper-division German. Richter

509. German Literature from 1800 through the Weimar Republic (3) II 1989-90 Readings of major prose and dramatic works between 1900 and 1933, in German. P, 6 units of upper-division German.

510. German Literature from 1933 to the Present (3) I 1990-91 Readings of major prose works from 1933, in German. P, 6 units of upper-division German.

511. Middle High German (3) II 1990-91 Intro-
duction to Middle High German language and literature from 1100 to 1500, read from representa-
tive literary works of the period. P, 302b, 315b. Classen

520. History of the German Language (3) II 1989-90 Introduction to Germanic philology; an overview of German language from its roots, in the Indo-European language family to New High German. P, 8 units of upper-division German. (Identical with Engl. 520) Classen

525. Beowulf (3) II (Identical with Engl. 525)

527a. Studies in Medieval Language and Lit-
erature (3) (Identical with Engl. 527a)

555. * Music and German Literature (3) I 1990-91 The interrelationship between music and German literature from the 18th through the 20th century. Concentrates on major works of German drama, poetry and prose, and their musical settings. Lectures in English-Readings primarily in English, some German. P, 202. (Identical with Mus. 555)

575a-575b. * Advanced Grammar and Style-
tics (3-3) I, II 1990-91 Practical training in written Ger-
man 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. Richter

579. * Issues in Foreign Language Teaching (3) I 1990-91 Issues in and methods of applied linguistics with emphasis on German as a foreign language. Schulz/Wildner-Baschnack

580. * Linguistics for Foreign Language Teaching (3) II 1990-91 Issues in and methods of applied linguistics with emphasis on Germanic languages. Schulz/Wildner-Baschnack

585. * Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II Application of computer to literary style, authorship, vocabulary measures, indexes and concordances, metrics and versification. P, 3 units of literature at the 300 level or above. (Identical with Engl. 585, Fre. 585, Clas. 585, Ling. 585, Russ. 585, and Span. 585)


596. Seminar i. Germanic Linguistics (3) [Rpt. I] III (Identical with Engl. 596i, which is home)

597. Workshop a. Translation (3) [Rpt./3] I II P, competency at third-year undergraduate level or pass departmental placement test.

601. Materials and Methods of Research (3) I Survey of the tools and methods of literary and linguistic research and introduction to principles of literary analysis. Chisholm/Classen

696. Seminar a. Comparative Literature (2-4) [Rpt.] I II
b. Linguistics (2-4) [Rpt.] I II (Identical with Engl. 696b)

c. Folklore (2-4) [Rpt.] I II (Identical with Engl. 696c)
d. Pedagogy (2-4) [Rpt.] I II

e. Translation (2-4) [Rpt.] I II

Gerontology (GERO)

Anthropology Building, Room 214
(602) 621-4086

Committee on Gerontology (Graduate)

Professors William A. Stini (Anthropology), Chairperson, Daniel R. Boone (Emeritus, Speech and Hearing Sciences), John T. Boyer (Internal Medicine), Herbert E. Carter (Biochemistry), Theodore H. Kolf (Management and Sport Science), Roy G. Spece, Jr. (Law), Charles W. Weber (Nutrition and Food Science)

Assistant Professors Alfred W. Kasznia (Psych-
ology), Douglas J. McAdam (Sociology), Jessie V. Pergrin (Nursing), Pamela G. Reed (Nursing), Stella Mae Smith (Special Education and Rehabilitation)

Assistant Professor Evan W. Kilgarn (Family and Community Medicine)

Because of its multidisciplinary nature, study in gerontology is located in a number of departments. The Committee on Gerontology plays a facilitating role in the coordination and development of aging studies and will guide students interested in incorporating a gerontological emphasis into their chosen field. Although no graduate major is offered, the Committee does offer a doctoral minor appropriate for students in areas such as health, administration, gerontology, psychology, and the social and behavioral sciences. A minimum of fifteen units is required for completion of a program. The program is also open to all students interested in pursuing a minor in gerontology. Students may be convened with 400-level course.

509. * Social Gerontology (3) II (Identical with Soci. 506)

510. * Psychological Problems of the Aged (3) II (Identical with Psych. 535)

511. * Economics of Aging (3) II (Identical with C.S. 536)


545. * Clothing for Special Needs (3) I (Identical with C.T. 545)

547. * Perspectives in Geriatrics Laboratory (1) I (Identical with Ph. Pr. 547)

548. * Perspectives in Geriatrics (2) II (Identical with Ph. Pr. 548)

557. * Law of the Elderly (2) II (Identical with M.A.P. 557)

570. * Human Adaptability I (Identical with Anth. 570a)

576. Communicative Aspects of Aging I (2) II (Identical with Sp.H. 576)

589. Health of the Older Adult (3) I (Identical with Nurs. 589)
Hygiene aspects including recognition, evaluation, and control of environmental and industrial hazards. (Identical with C.E. 586, G.En. 586, Mn.E. 586, and Tox. 586)

587.* Advanced Industrial Hygiene and Safety (3) An in-depth coverage of the industrial hygiene and safety professions emphasizing the principles of contaminant generation and the design of industrial hygiene/safety programs. P. 486. (Identical with C.E. 587, Tox. 587)

Exercise and Sport Sciences (EXSS)

Charles M. Tipton, Director, School of Health-Related Professions

The School of Health-Related Professions offers programs leading to the Master of Arts and Master of Science degrees with a major in exercise and sport sciences, and a Master of Education degree with a major in health education. A minor in exercise and sport sciences is available for doctoral students with majors in other disciplines. Students may specialize in exercise physiology at the Ph.D. level by majoring in physiological sciences (see that entry elsewhere in this catalog), an interdisciplinary major that incorporates faculty from 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 that is obtained in the exercise, health, and sport sciences. Students are permitted to use graduate or undergraduate courses for satisfactory completion of any perceived deficiencies.

Community and Environmental Health

1435 N. Fremont Avenue, Room 106

At the time this catalog was being edited, the Master of Education Degree with a major in health education was being redesigned. 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)

510.* Physical Exposures (3) 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. P. 2R, 3L. P. O.S.H. 486. (Identical with Tox. 510)

561.* Accident Prevention (2) (Identical with Mn.E. 561)

586.* Fundamentals of Industrial Hygiene (3) Introduction to the principles of occupational safety and health, with emphasis on industrial 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 TES and the etiology of stress-related health disorders. Also examines and applies stress management interventions to enhance performance and promote health. Williams

529. Psychological Interventions and Ergonomic Aids for Peak Performance (3) II The application and effectiveness of ergogenic aids mechanisms, particularly psychological interventions, in enhancing performance. P. 528 Williams

530. Advanced Physiology of Exercise (4) I Metabolic, cardiopulmonary, thermoregulatory, fluid-electrolyte, neuromuscular, and endocrine factors that influence physiological adjustments to acute exercise and the physiological adaptations to chronic exercise. P. 373 or 375. Tipton/Seals/Enoka/Lohman/Bunt/Fregosi

536. Administration and Sports Programs (3) Designed to provide a theoretical framework for students pursuing sports management careers and others interested in various functions involved in the conduct of sport programs. Miller

540. Exercise EKG Interpretation and Cardiac Medications (1) I Normal and pathologic functioning of the heart during rest and exercise. EKG interpretations, drug treatment for cardiac dysfunctions, and stress testing principles. P. 530

545. Evaluation and Regulation of Body Build and Composition (3) I Laboratory and field techniques for measurement of 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 375. Bunt/Fregosi

548. Nutrition in Sport and Exercise (3) II A critical analysis of research in the role of nutrition in physical performance. Emphasis on both nutritional deficiencies and supplements and their role in performance. The assessment of nutritional status, the interaction of exercise and nutrition in fitness and weight control programs. N.F.S. 310 or N.F.S. 410. (Identical with N.F.S. 548) Lohman

550. Advanced Exercise Physiology Laboratory (3) II Experiments designed to demonstrate basic concepts of physiological responses to exercise with emphasis on development of skills in laboratory instrumentation. emphasis is on the selection of newborn research. P. 530. Roby/Seals/Tipton/Bunt/Fregosi

560.* Biomechanics of Human Movement (3) I Analysis of human motion focusing on the mechanical interaction between the human body and the external environment. 2R-3L. P. 360 or 370, Ecol. 159a-159b, 160a-160b. Atwater/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
594. Practicum

a. Biomechanics (2) [Rpt./4 units] I P. 370 or 460.

595. Colloquium

b. Motor Control (2) [Rpt./8 units] II P. Psio. 460 and consult department before enrolling. (Identical with Psio. 695a, Psyc. 695a, Sp. H. 695a, S.E. 695a)

c. Exercise Endocrinology (2) [Rpt./8 units] II P. Psio. Martinez. John V. M. Potter, Jr., JoAnn Thomas

Consult the Division of Medical Technology for information on graduate courses.

596. Seminar

a. Motor Control of Data in Exercise and Sport Sciences (1) II Atwater

*May be convened with 400-level course.

693. Internship

a. Motor Control (2) [Rpt./8 units] II P. Psio. 160 and consult department before enrolling. (Identical with Psio. 695a, Psyc. 695a, Sp. H. 695a, S.E. 695a)

b. Exercise Endocrinology (2) [Rpt./8 units] II P. Psio. Martinez. John V. M. Potter, Jr., JoAnn Thomas

Consult the Division of Medical Technology for information on graduate courses.

695. Colloquium

a. Motor Control (2) [Rpt./8 units] II P. Psio. 160 and consult department before enrolling. (Identical with Psio. 695a, Psyc. 695a, Sp. H. 695a, S.E. 695a)

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Consult the Division of Medical Technology for information on graduate courses.

696. Seminar

a. Motor Control of Data in Exercise and Sport Sciences (1) II Atwater

*May be convened with 400-level course.
## Hydrology and Water Resources (HYDR/WRA)

**Geology Building, Room 122**

(602) 621-5082

Professors Daniel D. Evans, Acting Head, Nathan Buras, Donald R. Davis, Stanley N. Davis (Geosciences), Lucien Duckstein (Systems and Industrial Engineering), John W. Harbaugh, Richard H. Hawkins (Watershed Management), Simon Inc (Civil Engineering), Austin Long (Geosciences), William B. Lord (Water Resources Research Center), Thomas Stock III, Shlomo P. Neuman, Eugene S. Simpson (Emeritus), Ernest T. Smerson (Civil Engineering), Soorosh Soroshian

Associate Professors Randy L. Bassett, Michael D. Bradley, Assistant Professors Roger C. Bales, T.-C. Jim Yeh

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in hydrology and in water resources administration. The faculty offers competence in hydrogeology, hydrogeochemistry, ground-water hydrology, surface-water hydrology, mathematical and statistical methods in hydrology (including numerical modeling), and in water resources planning, management, and administration.

Applicants need not have completed an undergraduate major in hydrology. The programs have been developed to enable graduates from the basic sciences and from related fields such as geology, engineering, agriculture, meteorology, economics, and political science to enter directly. Applicants should submit Graduate Record Examination scores (general test only) and three letters of recommendation.

Graduate study programs are individually planned to meet the student's special interests and professional objectives. Certain basic courses in hydrology and water resources are required of each master's candidate unless equivalent courses were taken elsewhere. A thesis is required in the master's degree and, all students are expected to acquire a capability for computer programming.

Applications for admission to the Doctor of Philosophy degree program should have completed the Master of Science degree with a major in hydrology, water resources, or a related field. A thesis is required in the master's degree and, all students are expected to acquire a capability for computer programming.

### Majors

- **Hydrology:** The program is designed for students with special interest in the physical, chemical, and biological aspects of the hydrologic cycle as it relates to water resources. Students may concentrate in one or in a combination of these fields but should acquire some knowledge of relevant subject matter, 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 (HYDR)

### 502. Snow Hydrology (2) I 1990-91 (Identical with Ws. M. 502)

Kinematics and dynamics of fluids in saturated porous media, free surface, unsaturated, and multiphase flows. P. A.M.E. 331a or C.E. 321, Math. 422a. (Identical with C.E. 503)

### 503. Subsurface Fluid Dynamics (3) I Kinematics and dynamics of fluids in saturated porous media, free surface, unsaturated, and multiphase flows. P. A.M.E. 331a or C.E. 321, Math. 422a. (Identical with C.E. 503)

### 504. Numerical Methods in Subsurface Hydrology (4) I II Difference and finite element methods for subsurface fluid flow and mass or energy transport; applications to aquifers, unsaturated soils, seepage through earth dams, geothermal systems. P. Math. 422a. (Identical with C.E. 504)

### 506. Water Quality Dynamics (3) I Chemical and physical methods are used to study the quality of ground and surface water with emphasis on electrolyte chemistry, heterogeneous processes, colloids, and surface processes including sorption phenomena. Equilibrium and dynamic models of water chemistry. P. Chem. 480a or 450.

### 507. Hydrology of Unsaturated Media (3) I Physical properties and processes of unsaturated media related to storage and movement of water and transport of contaminants. (Identical with S.W. 507)

### 508. vadose Zone Monitoring (2) I Laboratory and field methods for characterizing water flow and contaminants in unsaturated geologic media. 6L. P. 407 or 507, 518.

### 514a-514b. Field Hydrology (Summer Camp) (3-3) I Field methods of collection, compilation, and interpretation of natural surface and ground-water hydrology; investigation of a small water resources project; preparation of hydrologic reports. Daily field work. Fee. P. 407/507, 423/523, 431/531, 519.


### 517. Fundamentals of Water Quality (3) I Introduction to chemical processes affecting the behavior of major and minor chemical species in the aquatic environment. Physical, equilibrium, organic, and analytical principles as applied to natural waters. 2R, 3L. Open to majors only. P. Chem. 103b, Phys. 103b, and Math. 125b.

### 518. Subsurface Hydrology (3) I Physical, mathematical, geologic, and engineering fundamentals to subsurface hydrologic processes. Open to majors only. P. A.M.E. 331a or C.E. 321; Math. 125b; Geos. 101a.


### 522. Well Logging Interpretation (3) II (Identical with G.En. 522)

### 523. Hydrology (3) I (Identical with C.E. 523)

### 531. Hydrogeology (3) I II (Identical with Geos. 531) Mathematical and hydrologic factors controlling occurrence and development of ground water. 2R, 3L. Field trips.


### 536. Development of Ground-Water Resources (3) I Analytic techniques to evaluate geohydraulic systems; case histories used to study management of ground- and surface-water resources; planning and design of regional water resource investigations. Field trips. P. Math. 535.

### 540. Advanced Surface Water Hydrology (3) I Fluvial dynamics and flood routing; flood hydrology; hydrology of water supply; classical and numerical methods. P. 423 or 523.


### 550. Environmental Hydrology (3) I Introduction to 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, S.I.E. 170.

### 557. Low Temperature Geochemistry (3) I (Identical with Geos. 557)

### 560. Watershed Hydrology (3) I (Identical with Ws. M. 560)

### 563. Isotope Hydrology (3) I (Identical with Geos. 563)

### 571. Water Quality Control (3) II (Identical with C.E. 571)

### 580. Hydrologic Systems (3) I Introduction to ground-water flow and transport modeling, with emphasis on model construction and simulation. 2R, 3L.


### 596k. k. Risk and Society (3) [Rpt./6 units] I (Identical with Anth. 596k, Geog. 596k, and Jour. 596k)

### 603. Well Hydraulics and Pumping Test Analysis (2) II 1990-91 Flow to wells in aquifers, with emphasis on design and interpretation of pumping tests; confined, unconfined, and leaky aquifer systems; fractured rocks; automatic curve matching. P. 503 or 535, Math. 422a.

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

### 642. Analysis of Hydrologic Systems (3) I Linear and nonlinear analysis of watersheds, aquifers and soil systems; hydrologic signal analysis; design and analysis of model building in presence of noise and in context of decision theory. P. 423, Math. 254.


### 655. Advanced Statistical Hydrology (3) I Advanced application of statistics and probabilistic methods to subsurface hydrology and contaminant transport, with emphasis on uncertainty and physical processes. 2R, 3L.
bility to hydrology and water resources; multivariate modeling, choice of models and parameters, simulation, Bayesian decision theory. P, 445 or 519 or 545 or Stat. 361.

576. Advanced Natural Resource Economics (3) (Identical with A.Ec. 576)

577. Natural Resource Economics and Public Policy (3) (Identical with A.Ec. 577)

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

581.* Environmental Policy (3) II (Identical with Pol. 581)

*May be converted with 400-level courses.

643. Water Resources Systems Analysis (3) I 1990-91 Applications of mathematical programming to the analysis of interactions of hydrology, engineering, economics, and socio-institutional environment in regional water resources systems. P, 544 or consult department prior to enrolling.

696. Colloquium a. Hydrology (1-3) [Rpt./1] I

696. Seminar
b. Unsaturated Flow (2-3) II
c. Regional Hydrologic Analysis (1-3) II P, 423, 431.
d. Desert Hydrology (1-3) [Rpt./2] II 1990-91

696. Seminar
e. Pollutants in the Hydrologic Environment (1-3) II
f. Advanced Hydrologic Modeling (1-3) II P, 642 or consult department prior to enrolling.

696. Seminar
h. Aquatic Chemistry of Surfaces (1-3) I 1989-90 P, 506.

Water Resources Administration (WRA)

501a-501b. Water Resources Policy and Administration (3-3) Institutional and policy aspects of water resources administration; management, organizational theory, and international problems of water use and development; ground-water management and policy. 501a is not prerequisite to 501b.

502.* 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. 502)


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.

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)

543.* Quantitative Planning Methods in Water Resources Administration (3) I Applications of quantitative methods to water resources management; benefit-cost analysis; optimization; structure and basis of planning process; principles and guidelines. P, microeconomics, Math. 125a.

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.

556. Finite State Methods in Water Resources Management (3) II 1990-91 Finite state methods; applications to natural resource systems as arise in hydrology, ecology, and earth sciences, including the modeling of interfaces such as socioeconomic processes. P, Math. 254, S.I.E. 170. (Identical with S.I.E. 556)

560. Ground-Water Management (3) II Management and management techniques for regional aquifer systems. Quantitative methods for both quantity and quality aspects of ground-water management. P, 444 or 544. (Identical with C.E. 560)

Associate Professors Ford N. Burkhart, William F. Greer, James W. Johnson, Jimmy D. Patten, Jacqueline E. Sharkey

The department offers a program leading to the Master of Arts degree with a major in journalism. The program is designed for students dedicated to developing or improving professional skills while attaining an academic background in one or more specializations.

An undergraduate major in journalism is not necessary for admission. However, students are required to complete 205, 206, and 320 as deficiencies without graduate credit.

A minimum of thirty units is required for the master's degree. Electives are chosen from courses related to fields of study with the approval of the advisor. A complete program of study must be approved by the graduate advisor in the first semester, and the advisor must approve any subsequent changes. No foreign language proficiency is required, although for those interested in Latin America, the department has an exchange program in Guadalajara.

Students are required to work on two department-produced newspapers and to demonstrate a high level of skill in reporting and writing courses. The program of study must include 502, 509, 511, 513, 596a, and 909. Advanced-degree credit will not be given for a grade lower than "B" in any professional, photojournalism, or editing course.

The graduate program has been accredited by the American Council for Education in Journalism and Mass Communications.

502. Freedom of Expression (3) II Analysis of access and barriers to information and communication at local, state, national and international levels; intensive study of the legal relationship between mass media and society. Open to majors only.

503.* Advanced Photojournalism (3) III Reporting and interpreting the news through photos, photo documentaries, and photo analysis. Open to majors only. P, 301, 302.

505.* The Study of News (3) II Critical study and problem analysis of the media. Field work may include publication of conclusions.

509. Media in the Twentieth Century (3) I The social, cultural, and economic role of a free press in an American society; interaction of press and government at judicial, executive, and legislative levels.

511. News Features (3) I II Writing the basic news feature article; specialized reporting and rewritings. Open to majors only.

512.* Reporting for Magazines (3) III Study of writing techniques for magazines; analysis of in-depth features. Students will write articles for publication.

513.* Reporting Public Affairs (3) III I Study and practice of newsgathering on executive, legislative, and judicial levels in city, county, state and federal governments, with emphasis on news sources and interpretive writing. P, 206, 502.

514. The News Agency: Arizona News Service (1) [Rpt.] II Role and operations of the news agency, wire service or syndicate. Class members will form staff of Arizona News Service to supply client newspapers from bureaus in Tucson and Phoenix. Field trips. P or CR, 411 or 413.

515.* The Editorial Page (3) III Critical study of the editorial page; emphasis on editors and public-affairs columnists; analysis of editorial pages in a changing society; writing of editorials. P, 206.

518. The Weekly Newspaper (3) II Community and suburban weeklies, including problems of news coverage, production, advertising and circulation, integration of electronic text systems. Field trips.
517.* Sports News Writing (3) Students will cover sports events and write sports features. Introduction and analysis of news organizations. P. 206.

519.* 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.

521.* Advanced Editing (3) II Study of layout and typography for news, photographs, and feature articles in newspapers. P. 320.


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 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, 320, 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 city of South Tucson. Intensive study of problems and requirements for daily journalism. P. 206, 208, 301, 320, 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
   a. History of Mass Media (3) I II
   c. Community Journalism (3) I II
   g. Journalism Education (3) I II
   h. Latin-American Press (3) I II
   i. News Analysis (3) I II
   k. Risk and Society (3) I (Identical with W.R.A. 596k, which is home)

597 Workshop
   a. Color Photography (2) [Rpt./1] S Two-week field trip. Fee.

Landscape Architecture
SEE Renewable Natural Resources

Latin
SEE Classics

Latin American Studies (LAS)
Social Sciences Building, Room 216
(602) 621-1137

Latin American Area Center
Director Michael C. Meyer
Assistant Director Raúl P. Saba

Committee on Latin American Studies (Graduate)

Professors Michael C. Meyer (History), Director, Donald W. Calton (Journalism), Roger Fox (Agricultural Economics), Lanin A. Gyurko (Spanish and Portuguese), Boris S. Kozolchyk (Law), Edward J. Williams (Political Science)

Associate Professor Celestino Fernández (Sociology)
Assistant Professor Raúl P. Saba

The Latin American Area Center offers an interdisciplinary program leading to the Master of Arts degree with a major in Latin American studies. Prospective students planning government, business, teaching, or related careers. The Center assists students in their career development by providing counseling and information relating to internships and careers.

Applicants should indicate the intended area of concentration. A faculty member from the area of concentration will evaluate the transcripts to determine whether there will be undergraduate deficiencies to be satisfied without graduate credit. Scores on the aptitude test of the Graduate Record Examination are strongly recommended.

The master's program consists of 35 graduate units, an area of concentration and two related areas. Minimum unit requirements are fifteen (including one research seminar) for the concentration and six for the related areas. Concentrations are available in anthropology, economics, geography and regional development, political science, history, Portuguese, and Spanish. Related areas may be cultural or professional and may be chosen from among the following areas: agricultural economics, anthropology, art, economics, English as a second language, educational foundations and administration, family and consumer resources, geography and regional development, political science, history, Portuguese, and Spanish.

Neither of the supporting fields may duplicate the principal field of concentration. Both Spanish or Portuguese proficiency are required, one at a level of competence and the other at a level of proficiency. Competence may be established by completion of Port. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. Proficiency may be established by completion of Port. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. The student and the advisor will discuss the prerequisites in selected courses relevant to their enrollment of properly qualified graduate students. No graduation degree is offered by the College of Law. The College welcomes, however, the entry of properly qualified graduate students in selected courses relevant to their degree objectives. Graduate students so enrolled may earn graduate credit as their per-

For information concerning the professional degree of Juris Doctor, see the College of Law Catalog.

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Applicants should indicate the intended area of concentration. A faculty member from the area of concentration will evaluate the transcripts to determine whether there will be undergraduate deficiencies to be satisfied without graduate credit. Scores on the aptitude test of the Graduate Record Examination are strongly recommended.

The master's program consists of 35 graduate units, an area of concentration and two related areas. Minimum unit requirements are fifteen (including one research seminar) for the concentration and six for the related areas. Concentrations are available in anthropology, economics, geography and regional development, political science, history, Portuguese, and Spanish. Related areas may be cultural or professional and may be chosen from among the following areas: agricultural economics, anthropology, art, economics, English as a second language, educational foundations and administration, family and consumer resources, geography and regional development, political science, history, Portuguese, and Spanish.

Neither of the supporting fields may duplicate the principal field of concentration. Both Spanish or Portuguese proficiency are required, one at a level of competence and the other at a level of proficiency. Competence may be established by completion of Port. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. Proficiency may be established by completion of Port. 405 or Span. 330 with a grade of B or above, or by an equivalency examination. The student and the advisor will discuss the prerequisites in selected courses relevant to their enrollment of properly qualified graduate students. No graduation degree is offered by the College of Law. The College welcomes, however, the entry of properly qualified graduate students in selected courses relevant to their degree objectives. Graduate students so enrolled may earn graduate credit as their per-
506. Research Methods (3) I II Need and opportunities for research in librarianship; types of research; research methodology; study of research design; elementary statistics.

580a. 580b. Literature for Children's Librarianship (3) I II Mexican-American Literature (3) I II Essentials for library public information activities, brochures, news releases and public service announcements for radio and television, communication problems at public service desks.

570. Literature of Science and Technology (3) I Creation, organization, and dissemination of science and technology information; reference function and problems of bibliographic control. A science background is not required.

571. Information Sources in the Social Sciences (3) I Advanced bibliographic and reference sources in the humanities and social sciences, with emphasis on the structure of knowledge in the various disciplines and evaluation of user services.

572. Government Information Resources (3) I Examination of the varieties of government publication available from municipal, county state, national and international agencies, with emphasis on selection and use of publications of the U.S. government.


576. Administration of Reference (2) I Theory of information service, policy development, special services, and administration of reference services. Open to majors only.

580a-580b. Literature for Children's Librarianship (3) I II Literature for younger children, including picture books. Traditional literature for use with children, Reference materials. Fantasy, humor, realistic fiction, poetry, classics, informational books. Criticism and reviewing of children's literature.

581. School Library Administration and Organization (3) I II Services, finances, personnel, evaluation, quarters, organization and technical services in the school library. Open to majors only.

582. Audiovisual Materials in Libraries (2) I Introduction to AV information resources for the library.

584. Oral Presentation of Children's Literature (2) I II Principles and techniques of storytelling and of reading aloud to children; stories for different age groups, presentation of picture stories, puppetry, picture books, and telling stories and in planning the story hour.

589. Scholarly Communication (3) I II Structure and workings of scholarly communication and communication in the context of contemporary society and technology of scholarly communication in various disciplines. (Identical with Comm. 589)

600. Introduction to Graduate/Study in Music (3) I II Introduction to Music (Identical with Mus. 600)

607. Planning Library Services (3) I The total planning cycle as a management approach to various library/information center services. Open to majors only.


615. Scientometrics and Bibliometrics (3) Examines quantitative techniques for measuring scientific and technical literature. Covers history and theory as well as current techniques. Emphasis on current research and theory.

620. National and International Information Policy (3) I Investigates the formulation and implementation of those national and international policies that govern the flow of scientific and technical information in the United States and between the United States and selected countries.

692. Internship

696a. Seminar
a. Clinical Practice (2-3) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
b. Business, Government and Society (3) I II Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
c. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
d. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
e. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
f. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
g. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
h. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
i. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.

696a. Seminar
j. Business, Government and Society (3) I Lawyering Skills Outside the Courtroom (2) I II P or CR, 696c or substantial clerkship experience.
b. Special Library (2-4) [Rpt./1] II S, P, 502, 503, 504, 505, CR 507 or CR 540.

c. Public Library (2-4) II S, P, 502, 503, 504, 505, CR 507 or CR 540.

d. School Library (2-4) [Rpt./1] II P, 580 (elementary only) or 585 (secondary only), 502, 503, 505, CR 581, 582.

e. Community College Library (2-4) [Rpt./1] II S, P, 502, 503, 504, 505, CR 507.

695. Colloquium

a. Theory of Classification (1-3) II
b. Issues in Library and Information Science (1-4) [Rpt./4 units]
c. Laboratory in Library Communications (1-3) II

696. Seminar

a. Current Research Trends (1-4) [Rpt./1] II
b. Government Information Issues (3)
c. Issues in Library and Information Science (1-4) [Rpt./1] II

504. Foundations of Syntactic Theory II (3) (II) Continuation of Ling. 503, with emphasis on recent literature.


510. Foundations of Phonological Theory I (3) An 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 the phonological component of grammar, including evidence for its interaction with morphological structures and rules.

511a-511b.* Modern Japanese Grammar (3-3) (Identical with Or.S. 511a-511b)

512.* Linguistic Structure of Modern Chinese (3-3) (Identical with Or.S. 520a-520b)

522a-522b.* Introduction to Phonology (3) [Rpt. /4 units] Current research in phonology, with emphasis on relationships among syntax, semantics, and phonology.

520a-520b.* Linguisitc Structure of Modern Chinese (3-3) (Identical with Or.S. 520a-520b)

522.* Linguistic Semantics and Lexicology (3) II 1990-91 Study of word and sentence meanings, relationship between the lexicon and the grammar, (identical with Phil. 522)

523a-523b.* Theory of Spanish Syntax (3-3) (Identical with Span. 523a-523b)

524.* Introduction to Arabic Linguistics (3) II (Identical with Or.S. 526)

527.* Applied Linguistics (3) [Rpt. with Span. 527]

540. Language Change and Reconstruction (3) II Introductory to the methods in, theory of, and problems in, linguistic reconstruction, of phonological, syntactic, and semantic data. Will be offered in 3 different topical areas. To be offered in conjunction with Phil. 522.

551. Language Acquisition (3) II (Identical with Or.S. 551)

551.* Linguistics and the Study of Literature (3) An introduction to the use of linguistic methods in the analysis of literature and implications of literary language for linguistic theory; detailed consideration of prosody, metaphor, narrative technique and style (identical with Cp.Lt. 561)

554. Formal Semantics (3) (Identical with Phil. 554)

555.* Pragmatics (3) 1989-90 Study of language use, its relationship to language structure, and the role of contextual information in interpretation, presupposition, implication, performatives, conversations. (Identical with Phil. 555)

557.* Natural Language Processing (3) Introduction to the processes underlying speech production and comprehension: speech sounds, words, parsing, semantics and pragmatics. (Identical with Phil. 557, Pscy. 575)

567.* Language in Culture (3) II (Identical with Anth. 576)

577.* Discourse and Text (3) II 1989-90 (Identical with Anth. 577)

680. Historical Comparative Linguistics (3) (Identical with Anth. 580)

583. Sociolinguistics (3) (Identical with Anth. 583)

685.* Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

588.* Computational Linguistics (3) Fundamentals of formal language theory, syntactic and semantic processing; the place of world knowledge in natural language processing. (Identical with C.Sc. 588 and Psy. 588)

595. Colloquium

a. Linguistics (1) [Rpt./3] I

600. Current Issues in Linguistic Research (3) [Rpt./1] Current research in linguistics, with emphasis on relationships among syntax, semantics, and phonology.

696. Seminar

a. Syntax and Semantics (3) [Rpt./2] II
b. Topics in Phonological Theory (3) [Rpt./2] II
c. Diachronic Linguistics (3) [Rpt./2] II
d. Current Issues in Syntactic Theory (3) [Rpt./2] II
f. Linguistic Investigations and Applications (3) II (Identical with Comm. 696f, which is home)
t. Topics in Experimental Phonology (3) II

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. Gottfriedson, Head, Michael Block, Don L. Bowen (Emeritus), Terence Connolly, Edwin B. Flippo, Theodore H. Kolf, James P. Logan, June M. Morrison (Emeritus), James E. Rigney (Emeritus), Thomas R. Navin (Emeritus), Arthur L. Silvers, George W. Summers (Emeritus)

Associate Professors Robert W. Buckingham, Marvin Fortman, H. Brinly Milward, Gregory B. Northcraft, Walter Powell (Sociology), David A. Tanski, Robert E. Tindall, Ronald J. Vogel

Assistant Professors Lawton R. Burns, P. Christopher Zerely, Jolene R. Galegher, David L. Torres, Douglas Wholey

The department offers a program leading to the Master of Science degree in management and policy with concentrations in: criminal justice administration, human resource management, organizational strategy, and policy and planning. The department also participates in programs leading to the Master of Business Administration, the Master of Public Administration, and the Doctor of Philosophy degree with a major in business administration. For information concerning these degrees see Requirements for Doctor of Business Administration and Master of Public Administration elsewhere in this catalog.

For admission, the applicant is expected to have completed undergraduate work in managerial accounting, economics, finance, organizational behavior, marketing, business law, business policy, statistics, and mathematics through calculus (Math. 119 and 123). Applicants must submit scores on the Aptitude Test
of the Graduate Record Examination or the Graduate Management Admission Test (GMAT). Admission to B.P.A. graduate programs is individually planned upon the recognition and analysis of legal problems facing top management in making and evaluating long-range plans, priorities, and legislation related to the needs of the aging in modern society. (Identical with Ping. 655)

671. Business, Government and Society (3) Study of the interactions, effects, and interrelationships of managers, employees, and organizational structures and systems. Open only to students admitted to a B.P.A. graduate program.

503. Human Resource Management (3) Principles, methods, research relevant to management of an organization's human resources, with emphasis on employment psychology, training development, compensation; P, 305 or 502.

504. Organization Development and Change (3) The interactions, effects, and interrelationships of managers, employees, and organizational structures and systems. Open only to students admitted to a B.P.A. graduate program.

505. Management Case Analysis and Presentation (3) Written analysis of cases and other reports; development of skills in analysis, decision making, and written and oral presentation, with emphasis on the total situation of each case considered. Open only to students admitted to a B.P.A. graduate program.

502. Organization Theory and Behavioral Management (3) Principles, methods, research relevant to persons 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 planning, and transportation and utility systems; subdivision planning and plat review. (Identical with Ping. 506)

507. Social Service Planning (3) Survey of the variety of planning efforts designed specifically to increase social welfare through the delivery of services using-historical, comparative, and evaluative perspectives. (Identical with Ping. 507)

514. Cost-Benefit Analysis (3) (Identical with A.Ec. 514)

535. International Management (3) I II S Analysis of management opportunities and challenges; evaluation and formulation of strategies of firms expanding internationally.

536. Finance for New Ventures (3) I (Identical with Fin. 536)

537. Marketing, Negotiation and Decision Tactics (3) I Development of bargaining and decision-making skills through simulated negotiations and role playing. Open only to students in the entrepreneurship program. P, Econ. 500a-500b, Fin. 511, Mktg. 500. (Identical with Mktg. 537)

539. Planning of New Ventures (3) I 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. Research Methodology (3) I Behavioral research techniques; bias, validity, reliability, and applicability; critique techniques; critiques of research articles and reports. P, M.I.S. 552.

557. Law of the Elderly (2) I Examines the law as it affects the elderly in such areas as legislation, finances, housing, death, guardianship, access to services and ethics. Focuses upon the recognition and analysis of legal problems and identification of legal resources. (Identical with Gero. 557)
Management Information Systems (MIS)

BPA Building, Room 406
(602) 621-2748

Professors Jay F. Nunamaker, Jr., Head, Seymour Goodman, Benn Kosinski III, James F. LaSalie, Averill M. Law, Roy E. Marsten
Associate Professor Nicholas Aquilano
Assistant Professors Joey George, Barat Kaku, Sudha Ram, Comprehensive Associate Professors Susan Sanchez, Olgain Sheng, Asoh Vakakaria, Doug Vogel, E. Sue Weber

The department offers a program leading to the Master of Science degree, and the Master of Science degree 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 (M.S. in Business Administration).

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 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 (696). Of the 30 units required for the Master of Science degree with a major in management information systems, at least 16 units must be at the 500 and 600 level.

501. Management Information Systems (3) I Introduction to computers and information systems. Use of personal computer productivity tools, word processing, and database management systems. Current topics such as expert systems and office automation. Open only to students admitted to BPA graduate programs. P, 507a, 507b.

507a-507b. Information Systems Architecture and Data Communications (3-3) I 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. Readings in Information Systems (3) II Provides a solid conceptual foundation in the structure, operation, and use of computer-based information systems in organizations. In-depth discussions of a collection of readings that represent classic MIS articles, significant research contributions, notable case studies, and/or tutorials. Areas include information systems perspectives, computers and cognition, decision support systems, expert systems, human-computer interface, and current topics in information systems. (Identical with Acct. 511) 521a-521b. Advanced Systems Modeling and Simulation (3-3) III The nature of simulation, simulation software, including animation model validation, selecting input probability distributions, random variate generation, statistical analysis of output data. Simulation of manufacturing systems that can be solved by analytical methods, but are not amenable to solution by simulation, SIMAN simulation language, and statistical issues in manufacturing simulation. Open only to students admitted to BPA graduate programs. P, 501, 502, Math. 119, knowledge of FORTRAN programming, probability and statistics. (Identical with C.Sc. 521a-521b)

522. Mathematical Programming and Applications (3) I II Overview of mathematical programming techniques and business applications. Emphasis on model building and problem description. Open only to BPA graduate students. 531a-531b. Data Structures and Database Management (3-3) III 531a: Abstract data types, data structures and their implementation in Pascal programs. Data structures covered include stacks, arrays, queues, linked lists, and trees. Introduction to concepts of database processing in comparison with file processing. Various tools needed for the logical and physical design of data 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) Analysis and logical design of M.I.S.; techniques for analyzing and documenting information systems requirements, hardware/software selection and acquisition, implementation planning 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) II Introduction to the role of technology and science in the Soviet social, political, and economic environment. Selected assessments of related technical and scientific achievements in Soviet technical and scientific developments. (Identical with Acct. 550a)


552. Mathematical Programming (3) I II Overview of mathematical programming techniques and business applications. Emphasis on model building and problem description. Open only to BPA graduate students. 572. Operations Management (3) I I ntended for students without a background in production management. Survey of techniques useful in planning and control of manufacturing and service production.


577. Discrete Mathematical Programming (3) Introduction to the formulation, solution, and implementation of discrete and integer mathematical programming models; representative applications will be studied and solved on 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 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, introduction to polynomial regression models. Analysis of variance and covariance, principal components, discriminant analysis, canonical correlation. P, 552 or Stat. 275. 582a is not prerequisite to 582b.

585. Material Requirements Planning and Control (3) II Material management with emphasis on forecasting and inventory theory within a dependent demand environment.

591. Special Topics in Research Methodologies in MIS (3-3) 591a: Introduces beginning doctoral degree students and advanced master's degree students to important research and survey articles in the field of management information systems. (Identical with Acct. 591b)

592. Discrete Mathematical Programming (3) II Advanced students. P, 501 or Math. 103.

595. Management Information Systems (3) III Management Information Systems. The department offers a program leading to the Master of Science degree, and the Master of Science degree 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 (M.S. in Business Administration).


598. Operations Management (3) II Advanced Topics in Operations Management (3) I 598a: Chaotic systems in manufacturing and service production. P, 501, 502, Math. 119, knowledge of FORTRAN programming, probability and statistics. (Identical with C.Sc. 521a-521b)

599. 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.

600. Artificial Intelligence and Expert Systems (3) 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 studied. Case studies will be presented. P, 422.


603. Decision Support Systems (3) II Introduction to decision support systems. P, 501 or Math. 103.


608. Artificial Intelligence and Expert Systems (3) 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 studied. Case studies will be presented. P, 422.


The science and engineering of materials hold the key to advances in many critical areas of high-technology—from integrated circuits and chip carriers to turbine engines and optical waveguides. Besides offering a plethora of such vital applications, the field of materials science and engineering abounds with scientific challenges of the first magnitude. Recognizing the opportunities in the field, the University and the Arizona Legislature have made a major commitment to build a center of excellence on materials.

Based on this commitment, the M.S.E. Department has attracted a group of world-class individuals to its faculty, and has developed a pioneering and wide-ranging curriculum at both the undergraduate and graduate levels. Funding from the state, the federal government and industry has provided modern facilities and supports research of ever-expanding scope and magnitude. Much of the research carried on in our new facilities, the Arizona Materials Laboratories (AML). The department has exciting research programs in areas as diverse as high-tech ceramics, non-linear optical materials, sol-gel and biomimetic processing, and polymers in electronics packaging. It has a long tradition of excellence in inorganic and physical metallurgy; and, in recent years, materials technology.

To attract the best students, the M.S.E. Department has attracted a group of world-class individuals to its faculty, and has developed a pioneering and wide-ranging curriculum at both the undergraduate and graduate levels. Funding from the state, the federal government and industry has provided modern facilities and supports research of ever-expanding scope and magnitude. Much of the research carried on in our new facilities, the Arizona Materials Laboratories (AML). The department has exciting research programs in areas as diverse as high-tech ceramics, non-linear optical materials, sol-gel and biomimetic processing, and polymers in electronics packaging. It has a long tradition of excellence in inorganic and physical metallurgy; and, in recent years, materials technology.

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dent acquires a thorough understanding of advanced work in the major field as well as in an appropriate minor. The dissertation, based on original investigation, must 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 to be entirely on a scientific aspect of materials, but may include economic and design considerations as well as scientific aspects of the problem.

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. Successful completion of the Ph.D. program in the department of Materials Science and Engineering includes the completion of at least 72 units of graduate courses beyond the B.S. degree. This will include: (a) 30 units (max.) from a completed M.S. degree program, courses in a minor program and 18 units of dissertation credit; (b) completion of specific courses such as M.S.E 510 (or its equivalent) and M.S.E. 595 and at least 9 units of 500 level courses in the department.

503. Applied Surface Chemistry (3) I Fundamentals of surface phenomena, characterization of solid surfaces, surfaces and interfaces, applications in ceramics, electronic and biomedical materials processing. P, a basic course in physical chemistry.


523.* Electrochemistry in Materials Science (3) I Principles and applications of electrochemistry in materials science with emphasis on solvation transfer and the electrochemical interface; including electrodeposition, electroforming, electrolyplating. P, 240.


531.* Science and Technology of Magnetic Recording Materials (3) I Magnetic properties of materials, materials for magnetic recording, technology of magnetic recording. P, a basic course in chemistry or materials science.

532. Fluid-Solid Interactions (3) I (Identical with Ch.E. 532)


535. Corrosion and 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, microprobe, and Auger analysis. 2R, 3L, P, 360, 480. Consult department before enrolling.

550.* Materials Processing (3) I Applications of transport phenomena and materials science to solidification and semiconductor growth; fundamentals of solids behavior to deformation processing. P, 409 or 331R.

550L.* Materials Processing Laboratory (1) I Laboratory experiments in solidification and mechanical forming processes. P, CR 450R.

551. Atomistic Computational Techniques in Materials Science (3) II Monte Carlo and molecular dynamics techniques, application to calculation of materials properties (structural, thermal, electronic, transport properties). P, 552 or other statistical mechanics or statistical thermodynamics course.

552.* Nondestructive Evaluation of Materials (3) II Introduction to the nondestructive evaluation of engineering materials. Methods considered include leak detection, penetrant, electromagnetic, radiographic, ultrasonic, electrical, electronic, eddy current, acoustic emission, and thermal. 2R, 3L. P, 331R or 360 or CS 134.

557. Integrated Circuit Technology Laboratory I (3) I (Identical with E.C.E. 557)


561.* Biological and Synthetic Materials (3) I 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.


563. Preparation of Glass (3) I (Rpt./2) II The glass transition, Kauzmann's paradox, kinetic theory of glass formation, physics and chemistry of glass making, glass structure, thermal properties. P, 470 recommended but not required.


579.* Culture and Materials Technology (3) I (Identical with Anth. 579)

580.* Experimental Methods for Microstructural Analysis (3) I An introduction, through a combination of lectures and laboratory experiences, to both established and new techniques for microstructural characterization of materials.

588.* Scanning Electron Microscopy (3) I Theoretical and practical aspects of electron microscopy, principles of electron microscopes and independent research using scanning electron microscopy and energy dispersive X-ray analysis. 2R, 3L. Field trips: Consult department before enrolling.

*May be conved with 400-level course.


595. Colloquium a. Materials (1) [Rpt.5] 1


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 117

(602) 621-2868

(See also Applied Mathematics)


The department offers programs leading to the Master of Arts, Master of Science, and Doctor of Philosophy degrees with a major in mathematics. Concentrations are available in pure, applied, computer mathematics or in probability and statistics. As there are no sharp boundaries between these concentrations, students are encouraged to pursue a broad range of study. In consultation with the department faculty. In cooperation with the College of Education, the department offers work leading to the Master of Education degree with a major in mathematics. For information concerning this degree see Requirements for Master's Degree/ Master of Education elsewhere in this catalog.

To be admitted, applicants must have completed a bachelor's degree in mathematics and have at least fifteen units of upper-division or higher level work including one semester each of advanced analysis at the level of Math. 425, modern algebra at the level of Math. 435, and linear algebra at the level of 431. Applicants are asked to submit scores on the Graduate Record Examination.

Examination.
514a-514b. Algebraic Number Theory (3-3) 1989-90 Dedekind domains, complete fields, class groups and class numbers, Dirichlet unit theorem, algebraic function fields. P, 515b.

515. Introduction to Algebraic Geometry (3) I Introduction to groups, rings, and fields. P, 423. II Algebraic geometry. P, 520. III Linear algebraic groups, complex manifolds, applications of algebraic geometry, e.g. to coding theory, combinatorial designs, crystallography, etc. P, 415.

517b. Group Theory (3-3) 1990-91 Selections from topics such as finite groups, non-commutative groups, abelian groups, characters and representations. P, 517b.

518. Topics in Algebra (3) [Rpt.] I Advanced topics in groups, rings, fields, algebras; content varies.

519. Topics in Number Theory and Combinatorics (3) [Rpt.] I Advanced topics in algebraic number theory, analytic number theory, class fields, combinatorics; content varies.


521. Fourier Series and Orthogonal Functions (3) I Linear spaces, orthogonal functions, Fourier series, Fourier transforms, orthogonal polynomials, Bessel functions. P, 254 or 255.

522a-522b.** Advanced Analysis for Engineers (3-3) I Laplace transforms, Fourier series, partial differential equations, vector analysis, integral theorems, matrices, complex variables. Credit allowed for 522a or 322, but not for both. Not applicable to M.A., M.S., or Ph.D. degrees for math majors. P, 254 or 255. 522b: Advanced Analysis for Engineers (3-3) Lebesque measure and integration, differentiation, Radon-Nikodym theorem, LP spaces, applications. P, 425.

527a-527b.** Elements of Complex Variables (3) I Complex numbers and functions, conformal mapping, calculus of residues. P, 223.

**Credit will be allowed for only one of 522a or 522, 524a-524b, 524 for one-semester course at the 400 level in the Master of Arts degree program.

525. Advanced Calculus I (3) I Continuity and Riemann integration in one or two dimensions, improper integrals, uniform convergence, series of functions, properties of the real number system, inverse function theorem. P, 223 and 423.

526. Advanced Calculus II (3) I Curves, surfaces, change of variables in multiple integrals; extremal problems; theorems of Green, Gauss, and Stokes; exact differentials. P, 425.

527a-527b. Principles of Analysis (3-3) I Advanced-level review of linear algebra and multivariable calculus; survey of real, complex and functional analysis, and differential geometry with emphasis on the needs of applied mathematics. P, 410, 424, and a differential equations course.


529. Topics in Modern Analysis (3) [Rpt.] I Advanced topics in measure and integration, complex analysis in one and several complex variables, probability, functional analysis, operator theory. P, 529b.

530. Second Course in Geometry (3) I 1990-91 Topics to be selected from projective geometry, algebraic geometry, metric geometry or combinatorial topology. P, 215.

531. Calculus I (3) I 1989-90 Euler equations and basic necessary conditions for extremum, sufficiency conditions, introduction to optimal control, direct methods. P, 254 or 255.

534a-534b. Topology (3-3) I Point set topology, homotopy, homology, applications, such as manifolds, duality, fixed point theorems, solutions to differential equations. P, 415, 425.


558. Topics in Geometry and Topology (3) [Rpt.] I Advanced topics in point set and algebraic topology, algebraic geometry, differential geometry; content varies.

559. Algebraic Coding Theory (3) II 1989-90 Construction and properties of codes, decoding algorithms, encoding and decoding procedures and information rate for various codes. P, 415. (Identical with E.C.E. 539)

563. Theory of Graphs and Networks (3) II Undirected graphs, connectivity, trees, partitions, planarity, coloring problems, matrix methods, applications in diverse disciplines. P, 215 or 223 or 243. (Identical with C.Sc. 543)


565. Discrete Mathematics (3) I 1990-91 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.

566. Topological Dynamics (4) II (Identical with Ecol. 550)

569a-569b. Partial Differential Equations (3-3) 1990-91 Theory and examples of linear partial differential equations of second order; 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.


571. Mathematical Theory of Chaos and Fractals (3-3) 1989-90 Qualitative theory of dynamical systems, phase space analysis, bifurcation, period doubling, universal scaling, onset of chaos. Applications drawn from atmospheric physics, biology, ecology, fluid mechanics and optics. P, 422a-422b or 454.

from a variety of fields, but all involving mathematical modeling and analysis; content varies.


588. Topics in Mathematical Physics (3) [Rpt.] I Advanced topics in field theories, mathematical theory of quantum mechanics, mathematical theory of statistical mechanics; content varies.

589. Nonlinear Wave Motion (3) II 1990-91 Nonlinear partial differential equations describing wave phenomena in water, gases, plasmas, lasers, shocks, modulated wave trains, parametric resonance, solitons and exactly solvable equations. P, 422b or 455 or 456.

596. Seminar
a. Topics in Mathematics (3) [Rpt./1] S
b. Mathematical Software (3) [Rpt.] I II P, 254 or 255, knowledge of "C" programming.*May be convened with 400-level course.


Medicine (MED/ANES/FCM/IMED/NEURO/OBG/OPH/PATH/PED/PSY/RAD/RONC/SURG)
Arizona Health Sciences Center, Room 2205 (602) 626-7383

Interdepartmental (MED)

595. Colloquium
y. Introduction to the Neurosciences I (2) 1989-90 P, Consult department before enrolling. (Identical with Anat. 595y, Ptcl. 595y, and Psio. 595y)

596. Seminar
Many interdepartmental seminars are numbered at both the 500 and the 800 levels. See 896 below for a complete listing.

801. Preparation for Clinical Medicine (1-12) II No grade is given until the full 12 units are completed.

802. Human Behavior and Development (6) I II

830. Supplementary Registration (1-9)

896. Seminar
a. Introduction to Forensic Pathology (1-3) II
b. Physical and Biological Basis of Nuclear Medicine (2)
c. Introduction to Computers in Medicine (2)
f. Clinical Epidemiology (2)
h. Human Sexuality (2)
i. Medical Jurisprudence (2)
j. Research Methods for Clinical and Epidemiological Studies (2) II
k. Fluid and Electrolyte Balance and Renal Immunology (2)
l. Pathophysiology of Respiratory Diseases (2)

*Available as both 596 and 896.

Anatomy
See Anatomy elsewhere in this catalog.

Anesthesiology (ANES)

Professors Burnett R. Brown, Jr., Head, Charles W. Otto, I, Glenn Sipes

Associate Professors Randall C. Cork, A. Jay Gandolfi, Stuart R. Hamefront,

800. Research (1-6) [Rpt./1]

810. Clerkship
a. Anesthesiology (1-8)

815. Subspecialty
p. Critical Care Medicine (1-18) (Identical with I.Med. 815p)

891. Preceptorship
a. Anesthesiology and Subspecialties (1-18)
c. General Anesthesiology (4-6)

Biochemistry
See Biochemistry elsewhere in this catalog.

Cancer Biology
See Cancer Biology elsewhere in this catalog.

Family and Community Medicine (FCM)


Associate Professors Peter J. Attarian, Daniel O. Levinsion, Ronald E. Pust, Arthur B. Sanders, Barry D. Weiss

Assistant Professors Dorian H. Cordes, Evan W. Kligman

500. Research (2-16) [Rpt./2], P, basic science courses.

515. Subspecialty
h. Cancer Epidemiology and Prevention (3) P, statistics helpful. (Identical with I.Med. 515h)

587. Poverty and Health (3) II (Identical with Nurs. 587b)

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

595. Colloquium
d. Special Topics in Cell Biology (2) [Rpt./6 units] II Open to students in biological sciences only. (Identical with Anat. 595d, M.C.B. 595d, I.Med. 595d)

596. Seminar
a. International Health (3) Open to health majors only.
b. Occupational Disease (1) II Open to medical or industrial hygiene students only. Consult department before enrolling.
c. Prevention and Control of Disease (1) II Consult department before enrolling.
d. Community and International Nutrition (1-3) II (Identical with N.F.S. 596n)
e. AIDS, Cancer, Nutrition Immunology (1) II
f. Diet and Prevention of Disease (2)
g. Psychosocial Epidemiology (2)

*Note: Some seminars are numbered at both the 500 and the 800 levels. See 896 below for a complete listing.

800. Research (2-16) [Rpt./2]

803. Clinical Clerkship (6-9)

811. Subinternship
a. Family Medicine (3-6) III S

815. Subspecialty
b. The Dying Patient (1-6) [Rpt./1]
c. Problems in Community Oriented Primary Care Medicine (3) I

d. Personal Change in Lifestyle Related Behavior (3-6) Consult department before enrolling.

e. Community-Based Care of the Older Patient (3-12) [Rpt./12 units] Field trips. Consult department before enrolling.

819. Preceptorship
a. Primary Care (6-12)

*Available as both 596 and 896.*
803. Clinical Clerkship (12)

811. Subinternship

b. Ambulatory Diagnosis and Therapeutics (6)
d. Ambulatory Geriatrics (3-12) P, 803.

815. Subspecialty

a. Clinical Cardiology Elective (4-8)
b. Clinical Dermatology (3)
c. Endocrinology (4-12)
d. Clinical Gastroenterology (4-8)
e. Hematology-Oncology (16)
f. Infectious Diseases (4-12)
g. Pulmonary Diseases (4)
h. Pulmonary Laboratory and Consultation Service (3-6)
i. Nephrology, Renal Diseases (3-6)
j. Clinical Allergy (1-6) (Identical with Ped. 815i)
k. Medical Subspecialties (3-6) (Rpt. 1)
l. Physical Medicine and Rehabilitation (4-6) [Rpt./1] CDT P, 3rd or 4th year medical school.
m. Critical Care Medicine (3-6) (Identical with Anes. 815p)

891. Preceptorship

a. General Medicine and/or Subspecialties (3-12) [Rpt./2]
b. Ambulatory Internal Medicine: Clinical Problems (5)

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.

Neurology (NEUR)

Professors Alan B. Rubens, Head, Peggy Ferry (Pediatrics), William A. Sibley
Associate Professor Colin R. Barnard
Assistant Professors William Feinberg, Steven Rapcsak

595. Colloquium

y† Introduction to the Neurosciences I (2) 1989-90 P. Consult department before enrolling. (Identical with Med. 595y, which is home).
z† Introduction to the Neurosciences II (2) 1989-90 P. 595y or consult department before enrolling. (Identical with Med. 595z, which is home).

800. Research (3-30) [Rpt./30 units]

803. Clinical Clerkship (12)

810. Clerkship

a. Ambulatory Care (4-6) [Rpt./12 units] II S P, completion of third year medical school.

815. Subspecialty

c. Cerebrovascular Disease (3) P, 803.

891. Preceptorship

a. Neurology (1-18) [Rpt./2]
b. Neurology Practice (3-6)

Obstetrics and Gynecology (OBG)

Professors C. D. Christian, Head, Jack Pearson, Lewis Shenker, Louis Weinstein
Associate Professors Diane S. Fordney, Kathryn Reed, William C. Scott

800. Research (1-18) [Rpt./1]

803. Clinical Clerkship (6-9)

810. Clerkship

a. Preparation for Practice (1-18)

815. Subspecialty

a. Obstetrics and Gynecology (4-6) II S

891. Preceptorship

a. Obstetrics and Gynecology (1-18)
b. Gynecology-Endocrinology (6)

Ophthalmology (OPHT)

Professor Barton L. Hodes, Head
Assistant Professors William D. Mathers, Kenneth N. Simons

800. Research (6-18) II

815. Subspecialty

a. Ophthalmology (3-6)

891. Preceptorship

a. Ophthalmology (1-18) P. Completion of clinical clerkships.

Pathology (PATH)

Associate Professors James M. Byers, III, Anna R. Graham, Thomas M. Grogan, Mary Jane Hicks, Douglas H. McKelvie, Ronald Schliman

801. General and Systematic Pathology (10) II

810. Clerkship

a. Anatomic Pathology (1-18)
b. Clinical Pathology (1-18)
c. Special Topics (1-18) [Rpt./1] P, 801.

891. Preceptorship

a. Pathology (1-18) [Rpt./2]

Pediatrics (PED)

Associate Professors John J. Huffer, Michael J. Schumacher, Elsa Sell, John N. Udall, Jr., Alanay Yates

800. Research (1-18) (See College of Medicine Electives Manual)

803. Clinical Clerkship (6-9)

810. Clerkship

b. Pediatric Care in a Cross-Cultural Setting (6)
c. Inpatient Pediatrics (6)

811. Subinternship

a. Ambulatory Pediatrics (1-18)
b. Behavioral and Developmental Pediatrics (1-18)

815. Subspecialty

a. Advanced Neonatology (6)
b. Pediatric Infectious Diseases (6)
d. Cardiac Ultrasound Echo and Doppler (4-6)
e. Pediatric Cardiology (6)
501. Radiation Biology (3) II Basic principles of radiation effects in mammalian cell and tissue systems, with emphasis on biochemical aspects, such as DNA damage and DNA repair, and cellular responses, such as cell kinetic defects and radiation repair and recovery; radiation and chemical (especially radioactive drugs) carcinogenesis, P, introductory biology and chemistry.

515. Subspecialty
h. Cancer Epidemiology and Prevention (3) I I, P, statistics helpful. (Identical with F.C.M. 515h, which is home)


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

989. Preceptorship
a. Pediatrics (1-18)

b. Preperation for Practice (1-18)

Pharmacology
See Pharmacology elsewhere in this catalog. Toxicology courses are listed under Pharmacology and Toxicology.

Physiology
See Physiology elsewhere in this catalog.

Psychiatry (PSY)
Professors Alan I. Levenson, Head, Allan Beigel, Larry E. Beutter (Psychology), Richard R. Bootzin (Psychology), Henry W. Brosin, Alfred W. Kasznak (Psychology), Mary P. Koss, Alayne Yates
Associate Professors Harold S. Arkowitz (Psychology), Diane S. Fordney (Obstetrics and Gynecology), David Nelson (Pharmacology and Toxicology), Catherine M. Shisslak (Psychology), Henry I. Yamamura (Psychology)

Assisstant Professors Peter J. Attarian (Family and Community Medicine), Shirley N. Fahey, Milton Frank

595. Colloquium
z. Introduction to the Neurosciences II (2) 1989-90 P, 595z or consult department before enrolling. (Identical with Med. 595z, which is home)

*May be converted 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. Subspecialty
a. Consultation Psychiatry (6) P, 803

f. Forensic Psychiatry (3-6) II S. P, 803.

891. Preceptorship

Radiation Oncology (RONC)

Professors J. Robert Cassady, Head, G. Timothy Bowden, Thomas C. Cetas, Eugene W. Gerner, Robert B. Roemer

Associate Professors Daniel L. McGee, Jeffrey Trent

Assistant Professors Anne E. Cress, Kullervo Hynynen, Bruce Lulu, Wendell Lutz, David Shimn, Baldassarre D. Stea

501. Radiation Biology (3) II Basic principles of radiation effects in mammalian cell and tissue systems, with emphasis on biochemical aspects, such as DNA damage and DNA repair, and cellular responses, such as cell kinetic defects and radiation repair and recovery; radiation and chemical (especially radioactive drugs) carcinogenesis, P, introductory biology and chemistry.

515. Subspecialty
h. Cancer Epidemiology and Prevention (3) I I, P, statistics helpful. (Identical with F.C.M. 515h, which is home)


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

891. Preceptorship
a. Pediatrics (1-18)

b. Preparation for Practice (1-18)

Medieval Studies
Social Sciences Building, Room 126 (602) 621-1586

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

815. Subspecialty
a. Urologic Surgery (3)

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 Research (3)

h. Lymphvascular System in Health and Disease (6-12)

i. Otoneurologicaly (3)

j. Sports Medicine (Section of Orthopedic Surgery) (1-6) [Rpt./1]

k. Orthopedic Bioengineering (3-6) P. Nine weeks of surgery clerkship, 803 and/or 803x

l. Trauma (3-6)

m. 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. Clinical Experience in Rehabilitation Medicine (1-4)

r. Vascular Clinical Management (4-8) [Rpt./8 units] P, completion of junior and senior rotations in surgery.

s. Emergency Medicine (3-12)

v. Clinical in Medical Ignorance (3-4) II P, junior standing.

891. Preceptorship
a. Surgery and Subspecialties (1-18) [Rpt./3]

896. Seminar
a. Medical Ignorance (2) [Rpt./1] II

Medieval Studies
Social Sciences Building, Room 126 (602) 621-1586

Committee on Medieval Studies (Graduate)

Professors John Boe (Music), Sigmund Einer (English)

Associate Professors Alan A. Bernstein (History), Chairperson, Jonathan Beck (French and Italian), Richard C. Jensen (Classics)

The Graduate Committee on Medieval Studies does not offer any major at this time. Programs constituting appropriate minors are available for doctoral students with majors in other disciplines. Students interested in the medieval studies minor must secure the approval of the committee in advance.

The program of study for the Doctor of Philosophy minor in medieval studies requires: a minimum of fifteen hours in graduate course work (note that no course may serve a student for both the major and minor); a reading knowledge of either classical or medieval Latin; knowledge of an old form of one language (for language majors, this requirement is in addition to the major field); a course in medieval history or culture such as art (for non-art majors), music (for non-music majors), or philosophy (for non-philosophy majors).

Related Courses
Refer to the appropriate department for course descriptions and unit values. Among those
courses which are applicable to the program are Art 512a-512b, 513a, 514, 596c: Class 501; Engl 566; 552, 520a-520b, 569a, 569c; Geol 511a-511b, 520a-520b, 569a; Hist 505a-505b, 506, 507; Ital 696a; Mus 500q, 530; Port 696a; Russ 583, Span 522, 541, 620, 696a, 696b.

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) 626-6062

Professors John J. Marchalonsis, Head, Harris Bernstein, Charles P. Gerba (Nutrition and Food Science), Junetsu Ito, Wayburn S. Jeter (Emeritus, Pharmacology and Toxicology), Rein Klikkoff (Physics), Peter P. Ludovici (Emeritus), William P. Olson, Kenneth-Ryan (Pathology), John Spizizen (Emeritus), Irving Yall (Emeritus)

Associate Professors Norval A. Sinclair, Associate Head, Robert J. Janssen, James T. Sinski

Assistant Professor Richard Friedman

The graduate program in microbiology and immunology has three major areas of emphasis: (1) molecular, genetic and physiological microbiology, (2) environmental, pathogenic and industrial microbiology, and (3) immunology. The research systems used include viruses, viroids, bacteria, bacterial plasmids, fungi, protozoans, parasites, cell and tissue culture, and animal models standardly used in immunological studies.

Master of Science and Doctor of Philosophy degrees with a major in microbiology and immunology are offered by a program whose faculty include members from a variety of different departments. The Microbiology Specialist degree is also offered.

Applicants are required to submit scores on the verbal, quantitative and analytical sections of the Graduate Record Examination. Scores in an advanced section are recommended. At least two letters of recommendation are required for both the M.S. and Ph.D. programs.

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, 243b.

503R. * Biology of Animal Parasites (3) I (Identical with VSc. 503R)

503L. * Parasitology Laboratory (1) I (Identical with VSc. 503L)


520L. * Pathogenic Bacteriology Laboratory (2) II Etiology and identification of pathogenic bacteria; techniques in pathogenic bacteriology. P, or CR, 420R. (Identical with VSc. 520L)

523R. * General Pathology (3) II General pathological studies. P, 520R, VSc. 523R)

523L. * General Pathology Laboratory (1) II (Identical with VSc. 523L)


527R. * General Mycology (3) I General mycology, with emphasis on the microfungi. P, 205.

527L. * General Mycology Laboratory (1) I General mycology laboratory, with emphasis on the microfungi. P, or CR, 527R.

528R. * Advanced Microbial Genetics (3) II (Identical with M.C.B. 528R)

528L. * Advanced Microbial Genetics Laboratory (1) II (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, 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)


545. Microbiology of the Rhizosphere (2) I 1990-91 (Identical with S.W. 545)

550. * Medical Mycology (4) II 1990-91 The isolation and identification of medical importance yeasts, P, 527L, or CR, 527R.

551. Environmental Carcinogenesis (3) I 1989-90 (Identical with R.Onc. 551)

552. * Molecular Mechanisms of Microbial Pathogenesis (3) I 1990-91 Review of current concepts in specific areas of microbial pathogenesis, including action of exo- and endotoxins, cell surface interactions, phagocytosis and host microbial functions. P, Bioc. 460.

555. Cancer Biology (3) II 1989-90 (Identical with R.Onc. 555)

556. Seminar (2) [Rpt.]

557. Seminar (2) [Rpt.

558. Seminar (2) [Rpt.

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566. Seminar (2) [Rpt.

567. Seminar (2) [Rpt.

568. Seminar (2) [Rpt.

569. Seminar (2) [Rpt.

570. Molecular Genetics (3) 1989-90 Molecular genetics and biology of the bacterial viruses; molecular mechanisms of gene regulation, DNA replication, DNA repair, mutation and genetic recombination; current research in bacterial genetics (lysogeny, transduction, conjugation, use of transposons and gene fusions in genetic analysis and transformation); introduction to gene cloning and its uses in analysis of gene structure and regulation. P, Bioc. 462a-462b.

571. Molecular Biology (3) 1990-91 Cells and cellular events involved in humoral and cell-mediated immune responses; morphologic, physiologic and biochemical characteristics of the lymphoreticular system. P, Bioc. 462a-462b.

571. Molecular Gene Cloning (3) II 1990-91 Current gene cloning technology; restriction endonucleases, cloning vectors (plasmid vectors and single-stranded phage vectors), gene amplification and cloning of cloned genes. (Identical with Gene. 571)

573. * Recombinant DNA Techniques (3) II (Identical with M.C.B. 573)


582. Immunotoxicology (2) I (Identical with Tox. 582)

595. Colloquium

d. Current Topics in Cell Biology (2) [Rpt.6 units]

596. Seminar

a. Current Problems in Molecular Biophysics (1) I (Identical with Phys. 596a, which is home)

b. Cancer Genetics and Cytogenetics (3) I 1989-90 (Identical with C.Bio. 596b, which is home)

c. Control of Proliferation in Animal Cells (1-2) I (Identical with R.Onc. 596b, which is home)

603. Immunology of Infectious Disease (4) II 1989-90 Methods for investigating changes in humoral and CMI during the disease process. Laboratory and library work for the preparation of a grant using NIH or NSF format. 12L. P, 419R, 560 or 561, Bioc. 460. Consult department before enrolling. (Identical with VSc. 630)

672. Food Safety (2) I 1989-90 (Identical with N.F.S. 672)


695. Colloquium

a. Readings in Microbiology (1) [Rpt.]

b. Molecular and Cellular Immunology (1)

c. Molecular Genetics of Microorganisms (1)

696. Seminar

a. Microbiology and Immunology (3-12) [Rpt.]

896. Seminar

h. Control of Proliferation in Animal Cells (1-2) I (Identical with Radi. 896h, which is home)
planning, geomechanics, operations research, robotics, mine health and safety, and the development of new and improved techniques. Advanced work in geological engineering is directed toward the fields of geophysical engineering, ground stabilization, earthquake engineering, urban planning, remote sensing, and conservation. Mineral economics is a field of applied economics encompassing the interface of minerals engineering and earth science with the business of mineral production and the setting of public policy.

Admission to graduate work normally requires the completion of an undergraduate major in these fields whereas mineral economics students frequently hold bachelor’s degrees in the mineral engineering discipline. Preparation in science and mathematics is also required. Students with undergraduate majors in other engineering fields or in the physical sciences, however, are encouraged to apply because training in such fields provides an excellent background for approaching some areas of graduate study in this department. The department requires that scores on the Graduate Record Examination be submitted by all applicants for admission to the graduate program.矿产经济学专业的学生通常拥有工程学专业的学士学位，但物理科学专业的学生也可能被鼓励申请。因为这些领域的培训为接近某些研究生学习领域提供了良好的背景。

518. * Field Studies in Geophysics (3) I II S Seismic, magnetic, electrical, and gravity techniques. Field trips, in many cases, may be required. P. 421 or 448 or 521 or 548. (Identical with Geos. 516) Sternberg
521. * Geophysical Engineering (4) I Principles of gravity, magnetic, electrical, electromagnetic, and geothermal phenomena and methods of acquisition and interpretation of data to define geologic structures for engineering projects and to evaluate resources. 3R, 3L. P, C.E. 516.
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. Field trips. Special fee may be required before enrolling. (Identical with Geos. 522 and Hyd. 522) Sternberg
525. * Geotechnical Investigations (3) II Investigation and analysis of geologic factors in the design and construction of engineering projects. 1R, 6L. Farmer
526. Principles of Health and Safety for Engineers (2) I (Identical with Mn.E. 526)
527. * Geomechanics (4) I (Identical with M.E. 527)
528. Developments in Rock Mechanics (2) I (Identical with M.E. 537)
544. * Mining Geology (2) I 1989-90 Collection, analysis and use of geologic data in the production of minerals; includes surface and underground mapping. P. Geos. 412. (Identical with Geos. 544)
548. * Geophysical Exploration: Potential Field Methods (4) I (Identical with Geos. 548)
557. Fundamentals of Geomechanics (4) II (Identical with M.E. 557)
560. Electrical Exploration Methods (3) II 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
561. * Accident Prevention (2) II (Identical with M.E. 561) Glass
567. * Computer Methods in Geological Engineering (3) II Use of computers to solve problems in geological engineering, including data bases, computer contouring, map filtering and interpretation, and numerical and statistical methods of geologic data. P. introductory courses in computer programming, mathematics, and earth science. Sternberg
568. Fundamentals of Industrial Hygiene (3) I (Identical with O.H. 568)
649. Probabilistic Methods in Geotechnical Engineering (3) II 1989-90 (Identical with G.E. 549)
660a-660b. Estimation of Mineral Resources by Quantitative Methods (3-3) 1989-90 (Identical with M.E. 660a)
660b. Estimation of Mineral Resources by Quantitative Methods (3-3) 1989-90 (Identical with M.E. 660a)
685. Forecasting for Mineral Industries (4) II Meteorology and long-term forecasting techniques applied to mineral industries: trend analysis, simple econometric models, exponential smoothing, and input-output analysis; case studies. P. 500, 550, 560, 584, or 586; Econ. 422, 501a or A.Ec. 504.
696. Seminar a. Research (1-3) [Rpt. I] II (Identical with M.E. 696a and Econ. 696a)
mining and construction. (Identical with G.En. 528L and Micr. 528L) 528.* Advanced Microbial Genetics (3) I Modern lab. techniques for genetic and molecular analyses of mammalian cells in culture. 6L. P, CR, 415. 529. Seminar a. Research (1-3) [Rpt. I I (Identical with G.En. 696a, which is home) • May be converted with 400-level course. 530. Molecular and Cellular Biology (MCB) Biosciences West Building, Room 308 (602) 621-7560 Professors Samuel Ward, Head, Head, D. Vasken Aposhian, George T. Bowden (Radiation Oncology), Wayne R. Ferris, William J. Grimes (Biochemistry), Mac E. Hadley (Anatomy), Richard B. Hallick (Biochemistry), John Hildreth and Ann Predock (Behavioral Medicine), Konrad Keck, Neil H. Mendelson, David W. Mount, James W. O'Leary (Environmental Research Laboratory), Peter E. Pickens, Nobuyoshi Shimizu Assistants Hans J. Bohnert (Biochemistry), Don P. Bourque (Biochemistry), Danny L. Brower, Jennifer D. Hall, Martinez J. Hewlett, Thomas J. Lindell, John W. Little (Biochemistry), Kaoru Matsuda Assistant Professors Gall Burd, James F. Death - erage (Biochemistry), Carol L. Dieckmann (Biochemistry), Martha Hawes (Plant Pathology), Roger D. Hall, Elizabeth Vierling (Biochemistry). The University Department of Molecular and Cellular Biology is a research-oriented department in which all students are engaged in research training in all aspects of research which employ cellular, molecular, biochemical, and genetic approaches. The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees with majors in molecular and cellular biology. Applicants for admission should be prepared in chemistry, physics, and mathematics and the GRE. The deadline for the Graduate Record Examination. Applicants must communicate directly with the department regarding other admission requirements. The deadline for completion of all application files is February 1. The deadline for the master's degree is April 1 (March 15 for applicants desiring financial assistance. Students are expected to specialize in areas of interest to the faculty. These include viral regulation, environmental biology, neurobiology of simple systems, cellular ultrastructure and function, structure and function of nucleic acids, developmental biology of higher plants, invertebrate development, molecular genetics, invertebrate developmental biology, environmental plant physiology, and gene transfer systems for mammalian cells. A listing of the faculty of the department and their research interests may be obtained from the department on request. A thesis is required for the master's degree. 510. Plant Molecular Biology (3) II 1990-91 (Identical with Bioc. 510) 511. Plant Molecular Biology I (3) I Advanced techniques in the application of radio -active tracers to problems of molecular biologist, molecular biology, molecular and genetic mechanisms of cell growth control. P, 181, 320, (413 or 513 recommended), Chem. 241a-241b, 243a-243b. (Identical with Bioc. 511.) 512. Plant Molecular Biology II (3) I Modern techniques for genetic and molecular analyses of mammalian cells in culture. 6L. P, CR, 415. 513. Advanced Cell Biology Laboratory (2) I Modern lab. techniques for genetic and molecular analyses of mammalian cells in culture. 6L. P, CR, 415. 514. Supramolecular Structure (2) II 1990-91 Application of diffraction techniques in the study of structure and function of biological macromolecules. 515. Molecular Cell and Molecular Genetics (2) I Modern concepts of eucaryotic cell genetics and molecular mechanisms of cell growth control. P, 181, 320, (413 or 513 recommended), Chem. 241a-241b, 243a-243b. (Identical with Bioc. 515.) 516. Computer Biology Data Analysis (3) I Processing of analytical data for solutions to problems in biology. P, Math. 125b. 528R.* Advanced Microbial Genetics (3) II Modern concepts of microbial genetics: basic genetic theory, the molecular architecture, biogenesis, and genetic regulation of bacterial cell structure, control of growth and cell division. P, 181, 320, (413 or 513 recommended), Chem. 241a-241b, 243a-243b. (Identical with Bioc. 528R.) 528L. Advanced Microbial Genetics Laboratory (2) I Individual research projects within the framework of microbial genetics, with emphasis on the use of microbial genetics to solve problems in molecular biology. (Identical with Ecol. 528L and Micr. 528L.) 543.* Insect Neurobiology (3) II (Identical with Ento. 543) 550. Topics in Pigment Cell Biology (2) I (Identical with Anat. 550) 555. Molecular Mechanisms of Development (3) II 1990-91 Detailed examination of molecular, genetic and cellular approaches to selected problems in developmental biology. P, 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)
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 graduate program in music education for students who wish to pursue a career in music education. All candidates for admission to the Ph.D. program in music education will show evidence of satisfactory competencies in their fields of concentration. There are two minimum units in music theory, one in a field of specialization in music, and one in a field related to the music major. The school also offers programs leading to the Doctor of Philosophy degree in musicology, music theory, and music performance. The school also offers a program leading to the Doctor of Musical Arts degree for students who wish to pursue a career in music performance. All candidates for admission to the Ph.D. program in music performance will show evidence of satisfactory competencies in their fields of concentration. There are two minimum units in music performance, one in a field of specialization in music performance, and one in a field related to the music major.
The interdepartmental Committee on Neuroscience offers a graduate program leading to the Doctor of Philosophy degree with a major in neuroscience, as well as a graduate minor in neuroscience. A Master of Science degree is offered only in rare instances when students who have already passed the M.S. evaluation requirement are unable to continue on the doctoral program. The committee comprises faculty members from several departments in the Colleges of Arts and Sciences, Engineering and Mines, Medicine, Nursing, Pharmacy, and the Arizona Research Laboratories. 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 to the following, the committee fosters research and consultation with students majoring in neuroscience. In addition to the following, the committee fosters research and consultation with students majoring in neuroscience.

Department of Engineering (ECE)

Engineering Building, Room 200
(602) 621-2551

Professors Robert L. Seale, Head, Barry D. Ganapol, Robert L. Hetrick, Richard M. Morse, George W. Nelson, Roy G. Post (Emeritus), Morton E. Wacks, Assistant Professors Brian W. Morris Farr, Rocco A. Fazzollar, William Filipone, Assistant Professor Leland M. Montith

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees 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 biophysics. Students may select one of the following interdisciplinary options: biomedical engineering or energy systems engineering. For details concerning these options see Engineering Design in another context.

The applicant should have completed the equivalent of the undergraduate major in nuclear engineering, and additional major 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. For the Ph.D. degree, except those working in the energy systems engineering option.

515. Environmental Analysis of Energy Conversion (3) Engineering analysis, assessment, and resolution of energy-environment interaction, with consideration of power plant siting, emission, thermal, and waste management.

516. 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.

517. 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.

520. Nuclear Engineering Laboratory (3) I II Exercise in the application of techniques of the various parameters in nuclear systems; experiments using the critical and subcritical reactors, P, 343 or 540.

530. Radiochemistry and Radiation Detection (3) I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. 2H, 3L. P, Chem. 480b or Phys. 330. (Identical with C.E.E. 530)

582. Topics in Nuclear Development (2) II 1989-90 An in-depth analysis of the cellular and molecular basis of nuclear 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 Nuclear Plasticity (2) I 1990-91 (Identical with M.C.B. 583)

584. Cellular Neurobiology (2) II 1989-90 (Identical with Anat. 584)


589. Principles of Systems Neurobiology (4) II Detailed introduction to the organization, physiology, and function of single neurons, emphasizing sensory systems, motor control, integration, and plasticity. P, 588, consult program office before enrolling. (Identical with Anat. 589 and Psio. 589)

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees 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 biophysics. Students may select one of the following interdisciplinary options: biomedical engineering or energy systems engineering. For details concerning these options see Engineering Design in another context.

The applicant should have completed the equivalent of the undergraduate major in nuclear engineering, and additional major 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. For the Ph.D. degree, except those working in the energy systems engineering option.

515. Environmental Analysis of Energy Conversion (3) Engineering analysis, assessment, and resolution of energy-environment interaction, with consideration of power plant siting, emission, thermal, and waste management.

516. 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.

517. 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.

520. Nuclear Engineering Laboratory (3) I II Exercise in the application of techniques of the various parameters in nuclear systems; experiments using the critical and subcritical reactors, P, 343 or 540.

530. Radiochemistry and Radiation Detection (3) I Radiation detection and measurement, health physics, isotope applications, activation analysis, and instrumentation. 2H, 3L. P, Chem. 480b or Phys. 330. (Identical with C.E.E. 530)

582. Topics in Nuclear Development (2) II 1989-90 An in-depth analysis of the cellular and molecular basis of nuclear 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 Nuclear Plasticity (2) I 1990-91 (Identical with M.C.B. 583)

584. Cellular Neurobiology (2) II 1989-90 (Identical with Anat. 584)


589. Principles of Systems Neurobiology (4) II Detailed introduction to the organization, physiology, and function of single neurons, emphasizing sensory systems, motor control, integration, and plasticity. P, 588, consult program office before enrolling. (Identical with Anat. 589 and Psio. 589)
solar cells, energy storage, systems for solar heating and cooling, and other technical applications.

568. * Photovoltaic Systems Engineering (3)
I Present system performance prediction methods, load estimation, power conditioners, control and protection systems, system design, and qualitative semiconductor device physics. (Identical with E.C.E. 567)

569. Industrial Energy Utilization and Management (3)
I Study of efficient utilization of energy in industrial operations: availability analysis, combustion, heat recovery, process energy, building systems, cogeneration, electrical loads, lighting and machinery. (Identical with E.C.E. 568)

570. * Energy Engineering 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. *May be taken as 400-level course.


583a-583b. Plasma Physics and Thermonuclear Theory (3-3) 583a: II Fundamentals of the theory of fully-ionized plasmas, including wave phenomena and stability of plasma fluids; introduction to thermonuclear theory. 583b: I Deposition of energy in thermonuclear plasmas; relaxation times and transport coefficients from Fokker-Planck theory; advanced subjects. (Identical with Phys. 583a-583b)

596. Seminar

630. Fuel Cycles for Nuclear Reactors (3) II 1990-91 The design and analysis of fuel cycles for nuclear reactors; the processes and requirements for fuel element design and the limitations of fuel element performance to reactor design; economic factors in fuel cycles. P, 540.


642. Reactor Theory II (3) II Fundamental theory of heterogeneous reactors, integral transport, blackness theory, perturbation theory, and applications; temperature coefficient, changes in reactivity due to fission product accumulations, fuel consumption, and conversion. P, 540.

643. Nuclear Safety (3) II Possible incidents involving nuclear materials in critical reactors, chemical processing systems, fuel shipment operations or subcritical arrays, including assessments of the magnitudes and consequences of nuclear incidents; determination of criteria for evaluating nuclear system safety, including plant siting and operational procedures. P, 343.

654. Nonlinear Reactor Dynamics (3) III Non-linear dynamics of nuclear reactors; shut-down mechanisms of systems, reactor safety criteria, time-dependent neutron transport, neutron waves, and applications to pulsed reactors, start-up transients, reactor stability, and reactor safety. P, 559.


681a-681b. Analytical Methods of Transport Theory (3-3) 1989-90 Application of the Boltzmann equation to neutron and photon transport problems; exact solutions, the method of singular eigenfunctions, spherical harmonic expansions, the moments methods, integral transport theory, and the definition of the transport equation. P, 642, Math. 422a-422b.

685. Inertial Confinement Controlled Fusion (3) I Advanced topics in inertial confinement fusion, including energy absorption and transport phenomena, stability of spherical implosion systems, laser and charged particle drivers and reactor designs. P, 483b, Phys. 470b. (Identical with E.E. 685)

687. Magnetic Confinement Controlled Fusion (3) II Theory and design of magnetic fusion systems; instabilities; transport and reactor design considerations associated with linear and non-linear systems. Texts: Stix, Mirror Mirrors; I.P., Phys. 415b, 470b. (Identical with E.E. 687)

**Nursing (NURS)**

Nursing Building, Room 316 (602) 626-6154

Professors L. Claire Parsons, Dean, Agnes M. Aamodt (Emerita), Jan R. Atwood, Eleanor E. Bawens, Pearl P. Coulter (Emerita), Ada Sue Hinshaw, Margarita A. Kay, Beverly A. McCord, Merle Mishel, Arlene M. Putt (Emerita), Gladys L. Badger, Jacqueline Blank, Carrie Jo Braden, Elizabeth Bright, Margaret E. Case, Associate Professors Evelyn M. DeWalt, Sandra Ferlitch, Rose Gerber, Mary E. Hazzard, Alice J. Longman, Lilian Lynch (Emerita), Betty J. McCracken (Emerita), Virginia Miller (Emerita), Carolyn Murdough, Alice L. Noyes, Jessie V. Pergrin, Linda R. Phillips, Lois E. Prosser (Emerita), Pamela Reed, Gayle A. Traver, Suzanne Van Ort, Joyce Veran, Mary Jane Welty (Emerita), Mary O. Wolanin (Emerita)

Assistant Professors Mary Alexander, Terry Badger, Jacqueline Blank, Carrie Jo Braden, Cheryl Cahill, Leanna Crosby, Wanda Frank, Louise Harris, Elaine B. Jones, Angela Leal, Nancy Kline Leidy, Mary Lynn, Kathleen May, Anne Woodtli

The College of Nursing offers programs leading to the Master of Science, Nursing Specialist, and Doctor of Philosophy degrees with a major in nursing.

Applicants for all degree programs are required to submit: (1) evidence of completion of an undergraduate program in nursing substantially equivalent to the Bachelor of Science in Nursing degree program at the University of Arizona, (2) a current license to practice as a registered nurse in one of the fifty states, (3) references attesting to professional competence, (4) evidence of satisfactory completion of a course in elementary statistics, (5) scores on the Graduate Record Examination, (6) a statement indicating academic and professional goals as well as research interests, and (7) evidence of skills in physical assessment. Computer literacy is encouraged.

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 Bachelor's Degree/Nursing Specialist elsewhere in the catalog.

Applications 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 cumulative grade-point average of 3.50, Graduate Record Examination scores of 1100 on the quantitative and verbal portion 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.

At the time of catalog editing, the requirements for the Master of Science and Doctor of Philosophy degrees were under review. Consult the College of Nursing for current information.

The College of Nursing graduate program is planned for four years and 108 units of 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.

*At the time of catalog editing, admissions criteria were under review. Consult the College of Nursing for current information.


587. Poverty and Health (3) I II Study of the relationship between poverty and health. Concepts and theories from anthropology, psychology, and sociology will be used to analyze problems associated with poverty. Advanced degree credit available for non-Ph.D. majors only. P, six units of social science. (Identical with Anth. 587 and F.C.M. 587)

588. Clinical Anthropology (3) II Application of principles from anthropological theory to the study of health and illness. Emphasis on culture content of groups living in the greater Southwest. P, nine units of behavioral science. (Identical with Anth. 588 and F.C.M. 588)

589. Family Nursing (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
I I Bilingual Health Communication (3) II (Identical with Anth. 595a, which is home.)

*May be taken as 400-level course.

600a-600b. Nursing Theory and Practice (3-3) I I S Maintenance, therapeutic and preventive nursing care of persons in various settings. Student elects practice in one area of nursing: 600a (I) child, 600b (II) 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 body physiology and physiologic responses secondary to alterations in perfusion, oxygenation, hydration, osmolarity, temperature, and resistance to infection. P, 586 or 3 hours of graduate credit in pathology.

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) II Examination of theories 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) II Examination of issues in providing care to families using theory and research from nursing and related fields. Concepts included will apply to the geriatric, adolescent, and family members. Open to majors only.

606. Social, Psychological Problems in Nursing (3) II Focus on concepts of stress and coping with emphasis on health-related outcomes. Nursing research on addictions, depression, anxiety, and violence will be explored. Open to majors only.

607. Cross-Cultural Nursing (3) Focus on the 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) S Client problems related to 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 processes to classroom situations. Each phase 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 educational concepts in a nursing care delivery setting. Focuses on the use of selected skills essential to effective administration. Open to majors only.

624. The Administrative Process (3) I Theoretical background for nursing administration in care settings. Emphasis is on accountability, budgeting, management skills, constraints, and influences as related to nursing administration. Open to majors only.

630. Methods in Nursing Research (3) II Critical examination of selected problems and methods in the research process. Consideration is given to both qualitative and quantitative methods.

631. Clinical Phenomena: Theories and Research (3) S Integration and research on the discovery and conceptual models with emphasis on description of conceptual models.

632. Research Utilization (3) S Development and use of models and tools for facilitating the use of research information in clinical practice within organizational settings. 2R, 3L, P, 360.

633. Evaluation Process in Nursing (3) I Development and use of models and tools for assessing nursing processes, programs, and performance in the nursing department. The relationship between research and evaluation is explored. Issues and development of market packages with cost consideration are discussed along with program grading.

705. Testing Nursing Theory (3) I Logical testing of theories in practice, history of nursing theory development related to basic epistemology, history, and philosophy of science; alternate metatheoretical structures, clinical theory development strategies; provision for an exercise in theory construction. Laboratory is required. P. 6 units of clinical specialty of clinical selective, 3 units of advanced human physiology, 3 units of social science at an advanced level.

706. Middle Range Theory (3) 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.

710. Quantitative Methods in Clinical Nursing Research (3) I Investigation of selected quantitative strategies appropriate to research problems in clinical nursing. P. 630, 633.

724a-724b-724c. Professional Role Development (1-1-1) I I I 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.

771. Qualitative Methods in Clinical Nursing Research (3) I Application of selected qualitative research methods from the social sciences to clinical nursing. P. 630.

775. Study of Social Influences (3) S In-depth examination of social forces affecting the health care system.

779. Quantitative Nursing Research (3) I Provides knowledge necessary to deal with clinical research, research design, methodology, and statistical methods appropriate to research in nursing. Emphasis on confirmatory and exploratory data, analysis issues, residual analysis is stressed. P. 771, graduate statistics course.

781a-781b. Instrument Construction (3-3) S Deductive and inductive processes for constructing/testing instruments to measure nursing care interventions/patient outcomes. 781a: Instrumentation for behavior and objective phenomena. 781b: Instrumentation for subjective phenomena. Includes instrument strategies, experience developing a pilot measure. 2R, 3L. Open to majors and minors only. P. 705, 710, graduate level statistics. 781a is not prerequisite to 781b. 781a and 781b are offered alternately in semesters.

782a-782b-782c. Field Work in Nursing Research (3-3-3) S I II Individualized course of study incorporating research and clinical knowledge in a selected area of nursing practice in the laboratory and field setting. P. 600a-600b, 630, 633, 705, 710.

Nutrition (See Nutrition and Food Science, 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 of organic chemistry with lab in addition to one year of either physics and 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 of either (identical or equivalent) of physics, general biology, organic chemistry with lab, biochemistry and physiology, and math (calculus recommended); for the M.S. in dietetics: completion of an ADA-approved Plan U.

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 540 or 558; 2 units of N.F.S. seminar; 1-6 units of N.F.S. thesis; 1 unit of N.F.S. 595a; 600-600-600-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 of biochemistry in nutritional sciences. P. Biochem 450 or 452a.

538. Problems in the Biochemistry of Aging (2) I 1989-90 Current topics in the biochemistry of mammalian aging, examination of the metabolic, immunological, and cellular aspects of aging in lower mammals and humans. P. One year of biochemistry. (Identical with Gero. 538) McLaughlin

540. Advanced Dietetics (3) I Nutrition and the management role as applied by the advanced-level practitioner. Open to majors in nutritional sciences only.

541. Therapeutic Nutrition (4) II Therapeutic nutrition and nutrient manipulation, 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. * testing in Geriatrics Laboratories (1) I 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, microorganisms of pathogens and beneficial organisms, chemistry, engineering, processing, analytical chemistry, laws, regulations, P. Chem. 241a-241b, 322; Mgr. 120 or 217, Phys. 102a-102b; Math. 117/S.

559. Sensory Evaluation of Food (3) I 1989-90 Fundamentals of taste, odor, color, and texture perception as related to food; design and methodology of small-scale and full-scale food analysis. P. Identical with An. S.S.

560. Advanced Food Chemistry (3) I 1989-90 Chemical and physical structure and functions of food constituents, additives, and food properties. P. 360 one year of biochemistry.


566. Postharvest Physiology (3) I 1989-90 (Identical with P.M. 566)

568a-568b. Food Processing (3-3) I 1989-90 Refrigeration, freezing, dehydration, heat treatment, nutritional and chemical change, and addition of chemicals, as they apply to food preservation and processing. Retention of
672. Food Safety (2) I 1989-90 Significance and control of foodborne hazards associated with pathogenic microorganisms, microbial toxins, industrial chemicals, and other environmental contaminants. P, Chem. 241b. (Identical with Micr. 672) Gerba

673. Food Microbiology and Sanitation Laboratory (2) II 1990-91 Laboratory procedures for assessment of sanitary quality of foods, P. or C. 475

674. Foods and Food Processing (2) II 1989-90 Current research in the processing of foods, including developments in processing and handling equipment. P. Micr. 120 or 217

675. Food Microbiology Laboratory (2) II 1990-91 Laboratory procedures for assessment of sanitary quality of foods, P. or C. 475

676. Seminar a. Nutrition (1) [Rpt./6 units] II (Identical with Nu.Sc. 696b)

677. Nutritional Sciences (NUSc) Shantz Building, Room 309 (602) 621-5630

Committee on Nutritional Sciences (Graduate)

Professors Donald J. McNamara (Nutrition and Food Science), Charles W. Weber (Internal Medicine), James W. Berry (Nutrition and Food Science), William H. Brown (Animal Sciences), James Blanchard (Pharmaceutical Sciences), Herbert E. Carter (Emeritus, Biochemistry), M. Meric Chihi (Surgical Surgery), David L. Earnest (Internal Medicine), Charles Gerba (Microbiology and Immunology), Gail G. Harrison (Family and Community Medicine; Pediatrics; Nutrition and Food Science), J. Tal Huber (Veterinary Sciences), Wayburn S. Jeter (Microbiology and Immunology), Mary Ann Kight (Nutrition and Food Science), Otakar Koldovsky (Pediatrics), K.Y. Lei (Nutrition and Food Science), Thomas Moon (Family and Community Medicine), George Olson (Microbiology and Immunology), Bobby L. Reid (Animal Sciences, Nutrition and Food Science), William F. McCaughey (Nutrition and Food Science), Ronald B. Zimmer (Family and Community Medicine), Louise Canfield (Biochemistry), Murray Korc (Internal Medicine), Douglas Park (Nutrition and Food Science), Ralph L. Price (Nutrition and Food Science), Cheryl K. Braaten (Animal Family and Community Medicine), W.A. Schurg (Animal Sciences), Edward T. Sheehan (Nutrition and Food Science), Roger A. Sunde (Nutrition and Food Science), Thomas Moon (Family and Community Medicine), John A. Marchello (Animal Sciences, Nutrition and Food Science), Thomas Moon (Family and Community Medicine, Pediatrics), K.Y. Lei (Nutrition and Food Science), Thomas Moon (Family and Community Medicine, Pediatrics), Louise Canfield (Biochemistry), Charles W. Weber (Nutrition and Food Science, Animal Sciences), Frank M. Whiting (Animal Sciences) Associate Professors Ronald E. Allen (Animal Sciences), Patsy M. Brannon (Nutrition and Food Science), Louise Canfield (Biochemistry), Murray Korf (Internal Medicine), Douglas Park (Nutrition and Food Science), Ralph L. Price (Nutrition and Food Science), Cheryl K. Braaten (Animal Family and Community Medicine), W.A. Schurg (Animal Sciences), Edward T. Sheehan (Nutrition and Food Science), Roger A. Sunde (Nutrition and Food Science), Spencer Swingle (Animal Sciences, Nutrition and Food Science), John Udall (Pediatrics) Assistant Professors Alan D. Bedrick (Pediatrics), Harinder Garewal (Internal Medicine), Paul Pollack (Pediatrics)

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, 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 advisors for students majoring in nutritional sciences. Research direction is available in all areas of nutrition, including nutritional biochemistry, human nutrition, clinical and community nutrition, and animal nutrition.

Undergraduate preparation must include one year of college-level mathematics (calculus recommended) and one year each of general biology, physics, and organic chemistry with laboratory. A semester of quantitative analysis is required for students selecting the options in nutritional biochemistry or animal nutrition. GRE scores for quantitative and verbal tests are requested for admission.

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 the option plus additional requirements specified by the student's graduate advisory committee, before obtaining the Ph.D. A maximum of ten units of individual studies (599, 699, 900) and seminar (595, 684, 695) credits will be counted toward requirements for the degree. A major may be chosen from a variety of areas including biochemistry, physiological sciences, molecular and cellular biology, ecology and evolutionary biology, food science, nutrition, anthropology, pharmacology, and chemistry.

Programs for both degrees will emphasize courses from the following listing.

Related Courses

Refer to the appropriate department for course descriptions. Among the courses that are appropriate for students majoring in nutritional sciences are Anthropology, Biochemistry, Biology, Chemistry, Microbiology, Nutrition, Food Science, Psychology, and Zoology.

Occupational Safety and Health (See Health-Related Professions)

Operations Management (See Management Information Systems)

Optical Sciences (OPTI)

Optical Sciences Center, Room 401 (602) 621-4111

Committee on Optical Sciences (Graduate)

Professors Robert R. Shannon, Chairperson, J. Rodgers P. Angel (Steward Observatory), George H. Atkinson (Chemistry), Harrison H. Barrett (Radiology), Peter F. Bartels (Psychology), James J. Burke, Charles M. Falco (Physics), Peter A. Franken (Physics), B. Roy
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. Among the currently being conducted include electro-optics, image formation, image processing, laser physics, materials, medical optics, non-linear optics, optical bistability, optical design, optical laboratory methods, properties of materials, pattern recognition, quantum optics, remote sensing, spectroscopy, surface physics, and thin-film technology. Interdisciplinary programs in progress involve major strengths of Astronomy, Chemistry, Civil Engineering and Engineering Mechanics, Electrical and Computer Engineering, Physics, and Radiology, as well as the Arizona Research Laboratory 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 completed set of transcripts, statement 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. Graduating students may elect either of two options.

**Thesis option:** A minimum of 32 units of graduate credit in optics or optics-related courses, including 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. The Master of Science degree requires, in addition to the breadth of knowledge, 501, 502, 503, 504, 505, 506, 507, 508, and 509 and that has been designed to prepare for the preliminary examination of the Doctor of Philosophy degree. In addition, these 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, as well as those majoring in other disciplines, may elect a minor in optical sciences. Such students must complete, for the minor, twelve units of course work with a grade of "B" or better in optical sciences or obtain a minor from another field of study. This coursework must be completed in the student's 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**

- Gauss's law; Coulomb's law; dipole; polarization; Faraday's law; Maxwell's equations; the wave equation; plane waves; spherical waves; Fresnel's formulas; diffraction; magneto-optic effects; electro-optic effects. P, Phys. 116, Math. 422.

**502. Introduction to Fourier Optics**

- Harmonic analysis; response; convolution; Fourier transform; transfer function; diffraction; image formation; holography; optical data processing. P, Math. 223.

**503. First-Order Optical Design**

- 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.

**504. First-Order Optical Design Laboratory**


**505. Introduction to Quantum Optics**

- Quantum background; interaction of radiation with matter; blackbody radiation; quantization of radiation fields; spontaneous emission; stimulated emission; lasers. P, 501, Phys. 230. (Identical with Phys. 504)

**506. Interference and Interferometry**

- Wave equations; energy flow; polarization; interference; coherence; interferometers; optical testing; heterodyne interferometry; holography; speckle interferometry. P, 501, 502.

**507. Interference and Spectrophotometry Laboratory**

- Laboratory in support of 505. P, CR, 505.

**508. Principles of Optical System Design**

- Sources of aberrations; aberration control; aberrations in simple systems; vision; color; mechanical design principles. P, 503, 503L.

**509. Introduction to Solid-State Optics**

- Solid-state background; lattice vibrations; energy bands; energy gaps; optical properties of insulators; semiconductors, measurement techniques, modulators, light-emitting diodes. P, 504.

**506. Probability and Statistics in Optics**

- Probability and statistics; stochastic processes; autocorrelation; Wiener spectrum; noise; applications in photography; atmospheric turbulence; analysis of random data. P, 502.

**509. Radiometry, Sources, Materials and Detectors**

- Sources; materials and components for optical systems; imaging and non-imaging detectors. P, 503, 503L.
interpretation; photogrammetry; image enhancement and classification; applications in the earth sciences.

558. Radiometry (3) I 1989-90 Units and nomenclature; Planck’s law; black bodies; gray bodies; spectral and radiative transfer; radiometric instruments; P, 509.

559. Infrared Techniques (3) I 1990-91 The radiative environment; atmospheric properties; optical materials and systems; detector description and use; data processing; displays, systems design and analysis. P, 558.

561. Photons of the Solid State (3) II (Identical with Phys. 561)


565. Radiation Detector Laboratory (2) I 1989-90 Operational amplifiers, noise, signal processing, photovoltaic and photodiode detectors, photomultipliers, thermal detectors. 6L. P, 509, CR, 566.

566. Optical Detectors (3) II 1990-91 Photoconductors, semiconductors, signal and noise mechanisms; figures of merit; limitations on the sensitivities of detectors; photomultipliers; detectors of ionizing radiation. P, 507.


568. Solid-State Imaging Devices (2) I 1990-91 Charge transfer devices; monolithic and hybrid focal planes; figures of merit; time-bandwidth product; fat zero; transfer efficiency; image transfer elements; buried-channel and surface-channel devices. P, 507.

570. Advanced Optics Laboratory (2) II Hands-on experience in current optics research areas. Emphasis is device-oriented. Guided waves; acousto-optics; optical bistability; diode lasers; nonlinear optics; optical phase conjugation. 1R, 3L. P, Phys. 121.


577. Optics of Thin Films (3) II Dielectric interference films; semiconductor, and metallic films; planar 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 1990-91 Fiber characteristics; fiber preparation; single and multimode fibers; sources; coupling; communication systems; multiplexing techniques; fiber-optic sensors.

*May be convened with 400-level course.

595. Colloquium a. Current Subjects in Optical Sciences (1) I II


598. Workshop a. Optical Shop Practices (3) I I I I II 1R, 6L. P, 513, 513L.


643. Quantum Optics (3) II 1990-91 Quantum theory of electromagnetic radiation; spontaneous emission; Dicke superradiance; optical coherence and noise; quantum theory of the laser; superconductivity and Josephson radiation. P, 543. (Identical with Phys 643) 656a-656b. Atmospheric Optics and Radiative Transfer (3-3) 1990-91 (Identical with Atmo. 656a-656b)

560. Microcomputer Interfacing in the Optics Laboratory (3) II Design and construction of interfaces between microcomputer systems and a variety of devices in the optics laboratory, including switches, motors, optical sensors, displays and terminals. Hardware and assembly language software drivers. 1R, 6L, P, C.S.C. 122 or E.E.E. 171.


Oriental Studies (ORS)
Franklin Building, Room 404 (602) 621-7505

Associate Professor William J. Wilson, Head, Michael E. Bonine, Marie Chan, Leslie A. Faltz, Donald L. Hildike, Chisato Kitagawa, Ronald L. Miao, Daniel Swetschinski
Assistant Professor John Y. Hou

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in Oriental Studies. Preparation in the field usually involves study in philosophy, history, religion, and language. The department requires three years of language study. Proficiency in a modern language is required. The major consists of four courses, two seminars, and a thesis, no fewer than 32 units. Two degree options are available: (1) a comprehensive major in a multi-area if desired, and (2) a specialist program with emphasis in changes in traditional roles during the colonial and post-colonial periods. (Identical with W.S. 561)

589. Women in East Asia (3) II (Identical with Hist. 589)

592. History of Sufism (3) II (Identical with Hist. 592)

596. Seminar b. Cultural Anthropology (1-3) II (Identical with Anth. 696b, which is home)

China

500a-500b. Literary Chinese (3-3) INTRODUCTION TO PRE-20TH-CENTURY CHINESE STYLes THROUGH READINGS IN CLASSICAL CHINESE LITERATURE. P, 410b.

510a-510b.* Advanced Modern Chinese (5-5) STUDY OF MODERN CHINESE THROUGH READINGS IN MODERN CHINESE LITERATURE AND NEWSPAPERS. P, 400b.

520a-520b.* Linguistic Structure of Modern Chinese (3-3) LINGUISTIC STUDY OF THE PHONOLOGICAL, MORPHOLOGICAL, AND SYNTACTIC SYSTEMS OF MODERN CHINESE, WITH PARTICULAR ATTENTION TO LINGUISTIC ANALYSIS. (Identical with Ling. 520a-520b)


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.

541a-541b. Chinese Historical Linguistics (3-3) 1990-91 Historical survey of the development of the Chinese language, with particular attention to linguistic changes in phonology, morphology, and syntax. P, 400b and a course in modern linguistic theory. (Identical with Ling. 540a-540b)

543.* Chinese Aesthetics (2) SURVEY OF TRADITIONAL CHINESE AESTHETIC CONCEPTS IN LANGUAGE, LITERATURE, PAINTING, CALIGRAPHY, AND DESIGN.


547. Readings in Classical Chinese Prose (3) [Rpt./] 1989-90 Readings in selected texts from literature, philosophical, and historical traditions; includes selections from the Five Classics and the great prose masters of the Han-Qing. Variable content. P, 500b.

550. Studies in Modern Chinese (3) [Rpt./] S Grammar, conversation, and readings in modern Chinese texts, with emphasis on oral and written comprehension and expression. P, 410b.


560.* World History. China. Foreign Relations (3) II (Identical with Pol. 560)

571. Chinese Historical Texts (3) [Rpt./] 1990-91 Readings in traditional historical texts of various types. P, 500b.
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. Sociology 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 early dynastic to modern society. (Identical with Hist. 582)

595. Colloquium
   a. China (3) [Rpt.] II
   b. Confucianism: The Classical Period (3) [Identical with Hist. 595i, which is home.]
   c. Confucianism: The Neo-Confucian Tradition (3) [Identical with Hist. 595j, which is home.]
   d. Revolution in Chinese History (3) [Identical with Hist. 595k]

596. Seminar
   a. Classical Chinese Literature (3) [Rpt.] II
   b. Modern Chinese Literature (3) [Rpt.] II
   c. Premodern Chinese History and Politics (3) [Rpt.] II
   d. Modern Chinese History and Politics (3) [Rpt.] II

586.* Political Systems of India and Pakistan (3) (Identical with Anth. 585)

572. History of Medieval India (3) I 1949-90 (Identical with Hist. 572)

573. History of Modern India and Pakistan: 1750-Present (3) II 1989-90 (Identical with Hist. 573)

585.* Social Organization of India and Pakistan (3) I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with Anth. 585)

586. Political Systems of India and Pakistan (3) II Survey of post-independence political developments in Pakistan and India. (Identical with Pol. 586)

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)

552.* Hindu Mythology and Literature (3) I Introduces major literary works with ancient Sanskrit myths. Selections from the Vedas, epics, Puranas and other classics in English translation.

570.* Religious History of India (3) (Identical with Hist. 570)

572. History of Medieval India (3) I 1949-90 (Identical with Hist. 572)

573. History of Modern India and Pakistan: 1750-Present (3) II 1989-90 (Identical with Hist. 573)

585.* Social Organization of India and Pakistan (3) I Survey of family, kin, and caste in the peasant societies of India and Pakistan. (Identical with Anth. 585)

586. Political Systems of India and Pakistan (3) II Survey of post-independence political developments in Pakistan and India. (Identical with Pol. 586)


567.* Population and Development 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. 567, Pol. 567, and Soc. 567)

584a-584b.* Akkadian Linguistics (3-3) (Identical with Anth. 584a-584b)

595. Colloquium d. Modern Arabic (3) [Rpt.] II I

Performance
(See Music)

Paleontology
(See Geosciences)

Persian
(See Oriental Studies)

Personnel Management
(See Management and Policy)

Pharmaceutical Sciences (PHSC)

Pharmacy Building, Room 408
(602) 626-4531


The Department of Pharmaceutical Sciences includes the academic disciplines of pharmaceutics, biopharmaceutics, pharmacokinetics, pharmaceutics, and pharmacognosy. It offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in pharmaceutical sciences. Concentrations within the major include pharmaceutical chemistry, biopharmaceutics, pharmacokinetics, pharmaceutics, and pharmacognosy.

A bachelor's degree in pharmacy, chemistry, or biological science is prerequisite to admission to the graduate program. Admission to the doctoral programs usually requires, in addition, appropriate preparation in mathematics.

Teaching is part of the graduate learning process, and one or more years of teaching is generally required of graduate students. A thesis based upon laboratory research is required for the master's degree. Acceptable minor fields for doctoral students include biology, chemistry, mathematics, microbiology, nutrition, pharmacology, physiology, zoology, or pharmacy concentrations different from the principal concentration selected by the student.
Specialized facilities of the College of Pharmacy available for graduate studies include a clinical pharmacokinetics laboratory, a mass spectrometry laboratory, a nuclear magnetic resonance facility, large-scale natural product extraction equipment, computer graphics facilities, animal facilities, and well-equipped laboratories for chemical synthesis, structure elucidation, and pharmacodynamics research.


508a-508b. *Pharmacokinetics Discussion* (1-1) I II Discussion related to the application of pharmacokinetic principles with case-study examples. CR, 407 for 408a, 885 for 408b. (Identical with Ph.Pr. 508a-508b)

512. Quantitative Structure-Activity Relationships (3) 1989-90 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; molecular 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 of drugs and their biological activity, incompatibilities and stability of the organic and inorganic compounds obtained from natural and synthetic sources; essentials of pharmacognosy, including biologicals. P, 302b, Chem. 241b, 424b.

*May be conveined with 400-level courses.*

596. Seminar 1990-91 Applications of physical chemistry to pharmacy. P, physical pharmacy or physical chemistry courses.


630a-630b. Advanced Organic Medicinals (3-3) 1990-91 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 1 I Research (3-10) II 15-30L. P, 30L. 10 units of 810. (Identical with Ph.Pr. 815I, which is home.)

885. Advanced Clinical Pharmacokinetics (3) II (Identical with Ph.Pr. 885).

**Pharmacology (PHCL)**

Pharmacy Building, Room 236 (602) 626-7218

(Pharmacy, College of Medicine)

Professors Thomas F. Burks, Head, David S. Alberts (Internal Medicine), H. Vasken Apkarian (Psychiatry and Behavioral Sciences, Cellular Biology), Klaus Brendel, Rubin Bressler (Internal Medicine), Burnell R. Brown (Anesthesiology), Ryan J. Huxtable, David G. Johnson (Internal Medicine), Eugene Morkin (Internal Medicine), Carol J. O'Toole (Anesthesiology, Surgery), William R. Roesske (Internal Medicine), I. Glenn Sipes (Pharmacology and Toxicology), Henry I. Yamamura

Associate Professors Dean E. Carter (Pharmacology and Toxicology), Kenneth A. Conrad (Internal Medicine), Thomas P. Davis, Timothy C. Fagan (Internal Medicine), Edward D. French, A. Jay Gandolfi (Anesthesiology), Margaret J. Hallon, David L. Kreulen, Thomas J. Lindell, Frank Porreca Assistant Professor Laurel A. Fisher

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 in Pharmacology and the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry for the Committee on Pharmacology and Toxicology for details on admission and degree requirements.

Pharmacology is a broad discipline involving the investigation of the actions of chemicals upon living material at all levels of organization. It occurs within the framework of 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 pharmacology and the basic sciences; pharmacological knowledge is applied to the understanding of the basic mechanisms of drug action, the diagnosis, prevention, cure, or remediation of disease and the promotion of optimal health. The emphasis on basic pharmacologic principles enables the student to develop techniques of problem-solving to keep abreast of advances in pharmacology and its applications to other sciences.

501. The Pharmacological Basis of Therapeutics (6) II Actions of chemical agents upon living material at all levels of organization, with emphasis on mechanisms of action of prototype drugs; foundation for a rational approach to human therapeutics and toxicology. P, Psio. 601, Bioc. 501. (Identical with Tox. 501)


551. Molecular Biology of Pharmacological Agents (3) I 1989-90 Molecular mechanism of drug action, including transport and subcellular functions at the cellular and subcellular levels, including effects on control mechanisms, cell-cell interactions, organelles, and nucleic acid and protein synthesis. P, 501, 550, 561b, Bioc. 501. (Identical with Tox. 551)


561a-561b. Introduction to Pharmacological and Toxicological Literature (1-1) Designed to broaden the background of students in pharmacology and toxicology, and to improve scientific communication skills. P, 501. (Identical with Pcol. 561a-561b)

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

582. Immunotoxicology (2) I (Identical with Tox. 582)

586a-586b. Introduction to Pharmacology and Toxicology Research (1-1) Introduction to basic research techniques in pharmacology and toxicology through supervised laboratory rotations; student-initiated and faculty-structured lab. exercises in modern pharmacological and toxicological techniques. P, CR, Bioc. 565, Psio. 601.

595. Colloquium I Introduction to the Neurosciences I (2) 1989-90 P Consult department before enrolling. (Identical with Med. 595y, which is home.)

*May be convened with 400-level course.*

596. Seminar 1990-91 Advanced Graduate Research (1-3) (Rpt/3) I II P, 561b. (Identical with Pcol. 596a)

601. Analytical Instrumentation and Techniques (4) I (Identical with Tox. 601)

602a-602b. Biostatistics (3-1) (Identical with Tox. 602a-602b)

653. Neuropharmacology (3-4) II (Identical with Pcol. 653)

695. Colloquium I Cellular M/Molecular Pharmacology (1-3) I (Rpt/4 units) I II P, Bioc. 462a-462b, 568a-568b and/or Phcl. 551.

800. Research (1-6)

801. The Pharmacological Basis of Therapeutics (6) II


891. Preceptorship I Pharmacology (3-12) (Rpt/12 units)

**Pharmacology and Toxicology (PCOL/TOX)**

Pharmacy Building, Room 236 (602) 626-2823

(Pharmacy, College of Pharmacy)


Assistant Professors Cliff Crutchfield (Family Medicine), Burghard R. Brown (Anesthesiology, Surgery), Robert T. Orr (Internal Medicine), Daniel C. Leibler, John Sullivan (Emergency Medicine and Pharmacology)

Pharmacology is the science concerned with all aspects of the actions of drugs and other chemicals on living systems. Its primary aim is the discovery of chemical mechanisms by which cellular and molecular functions are regulated for the purpose of understanding how...
existing drugs and to develop new drugs for treatment of diseases. The broad scope of interests of pharmacology ranges from the study of intermolecular reactions of chemical constituents of cells with drugs to the effects of chemicals in our environment on entire populations.

Toxicology is the science concerned with the harmful effects of chemicals (including drugs) on living systems. The toxicology program manages the University of Arizona Toxicology Laboratory. The program prepares students for careers in hospital laboratories, police crime laboratories, medical examiners' offices, industrial hygiene laboratories, and toxicology laboratories in industry, government, and universities. The broad scope of interests in toxicology ranges from determining the mechanisms by which chemicals produce adverse biological effects to identification, and quantification of hazards resulting from occupational and/or environmental exposure to chemicals.

Industrial hygiene is the applied science concerned with the recognition, evaluation, and control of chemical and physical agents that can affect health status in occupational and environmental settings. An industrial hygiene concentration is offered within the Master of Science toxicology program. The concentration prepares students for professional practice in a wide range of both private and public sector organizations.

A Doctor of Philosophy degree in this discipline is awarded through the Graduate Program in Pharmacology and Toxicology.

Pharmacology

The Department of Pharmacology and Toxicology in the College of Pharmacy cooperates with the Department of Pharmacology in the College of Medicine, through the Committee on Pharmacology and Toxicology, in offering programs leading to the Master of Science degree with a major in pharmacology and the Doctor of Philosophy degree with a major in pharmacology and toxicology. See the entry under Committee on Pharmacology and Toxicology elsewhere in this catalog for details on admission and degree requirements.

Pharmacology (PCOL)

561a-561b. Introduction to Pharmacological and Toxicological Literature (1) (Identical with Phcl. 561a-561b)
571a-571b.* Fundamentals of Pharmacology (4-4) Comprehensive study of the bio-chemical, physiological, and therapeutic effects of drugs, including mechanisms of drug action and drug toxicity, and drug literature evaluation. 3R, 3L. P. Anat. 401, Bioch. 460, 481, CR. Ph. Phc. 471a-475b and Ph. Sc. 437a-437b. (Identical with Toxic. 571a-571b)
572.* Applied Pharmacology (3) I II Pharmacodynamics, pharmacokinetics, adverse effects of commonly used drugs, with emphasis on clinical applications. Not available for elective credit in the College of Pharmacy or graduate credit in pharmacology-toxicology doctoral programs. P. 472 or 471b, Ph. Sc. 407. (Identical with Toxic. 572)
574.* Clinical Toxicology (2) I Prevention, characteristics, diagnosis and rational management of diseases caused by drug overdose, toxic household products, poisonous pets, venomous animals, environmental and industrial toxics. P. 472 or 471b, Ph. Sc. 407. (Identical with Toxic. 574)
596. Seminar a. Advanced and Graduate Research (1-3) [Rpt./3] I II (Identical with Phcl. 596a, which is home)
653. Neuropharmacology (3-4) II Role of various neurochemicals in the peripheral and central nervous systems and the effects of drugs on the nervous system, including their actions at receptors and their influence on synthesis, storage, and release of neurotransmitters. P. Phcl. 501 or Pcol. 471b, 561a, 596. (Identical with Phcl. 653 and Toxic. 653)

Toxicology

815. Pharmacy Subspecialty I. Research (3-10) I II S 15-30L. P or CR, 10 units of 815. (Identical with Ph.Pr. 815, which is home.)

Toxicology

The Department of Pharmacology and Toxicology in the College of Pharmacy offers a curriculum leading to the Master of Science degree with a major in pharmacology and toxicology. Admission requirements for admission are 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 with two letters of recommendation and adequate scores on the Graduate Record Examination are also required for admission. Required courses for the graduate program are 554, 563a, 563b, 565, 571a-571b (or Phcl. 501), 574, 596a, 596b, 601, and 602a-602b. A thesis is required.

Industrial Hygiene

Admission requirements for the industrial hygiene concentration are identical to those for the Master of Science degree in toxicology. Required courses for the industrial hygiene concentration are 554, 565, 580, 581, 586, 587, 596a, and F.C.M. 596. A summer internship is recommended, and a thesis is required.

Toxicology (TOX)

501. The Pharmacological Basis of Therapeutics (6) II (Identical with Phcl. 501)
508. Insecticide Toxicology (3) II 1989-90 (Identical with Ento. 508)
510.* Physical Exposures (3) II (Identical with O.S.H. 510)
523R.* General Pathology (3) II 1990-91 (Identical with V.S.C. 523R)
523L.* General Pathology Laboratory (1) II 1990-91 (Identical with V.S.C. 523L)
550. Drug Disposition and Metabolism (2) II (Identical with Phcl. 550)
551. Molecular Biology of Pharmacological Agents (3) I 1989-90 (Identical with Phcl. 551)
554. Industrial Toxicology and Chemical Exposure (3) I 1989-90 (Identical with Phcl. 554a-554b)
554a-554b.* Human Physiology (3-3) (Identical with Ecol. 554a-554b)
565. Statistics for the Medical Sciences (4) I (Identical with Stat. 565)
571a-571b.* Fundamentals of Pharmacology (4-4) (Identical with Pcol. 571a-571b)
574.* Clinical Toxicology (2) I II (Identical with Pcol. 574)
587.* Environmental Toxicology (3) I Toxicity of natural toxins and of agricultural and industrial chemicals, with emphasis on air and water pollutants; decision-making in environmental issues. P. 6 units of biology and organic chemistry. P. 472, 473, 326. (Identical with Ento. 576 and Phc. 576)
580.* Human Physiology (4) II (Identical with Psc. 580)
581.* Industrial Ventilation (3) II 1989-90 Design and evaluation of industrial ventilation systems. Emphasis is on level evaluation of industrial contaminants. Five laboratory exercises and course design project. 3R, 1L.
582. Immunotoxicology (2) I 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. 602a-602b, Micr. 419, 567. (Identical with Phcl. 582 and Pcol. 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)

Pharmacology and Toxicology

Committee on Pharmacology and Toxicology (Graduate)

Professors I. Glenn Sipes, Chairperson, Klaus Brendel, Thomas F. Burks

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, in offering programs leading to the Master of Science with a major in pharmacology and the Doctor of Philosophy with a major in pharmaceutical sciences in biochemical, molecular, behavioral, cardiovascular, endocrine, gastrointestinal, and autonomic pharmacology and toxicology in biochemical, occupationally induced, inhalation, and environmental toxicology.

Admission requires the completion of a bachelor's degree with a major in chemistry, biology, pharmacy, or other related science. Minimum requirements include two years of college including one year each of analytical chemistry, biological science, and organic chemistry. The Department of Pharmacology and Toxicology 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 pharmaceutical sciences in biochemical, molecular, behavioral, cardiovascular, endocrine, gastrointestinal, and autonomic pharmacology and toxicology in biochemical, occupationally induced, inhalation, and environmental 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 344  
(602) 626-5730

Professors J. Lyle Bootman, Head, William F. McGhan, Theodore G. Tong  
Assistant Professor Lon N. Larson

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 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 II (1) I (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) II P, 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 non-majors. (Identical with Gero. 548).**

589.** Clinical Pharmacotherapy of Mental Disorders (2) I II A multidisciplinary approach to clinical psychopharmacology, therapeutics, and diagnosis of mental disorders for health professionals.**

596. Seminar  
a. Pharmacy Administration (1) [Rpt./5] I II  
b. Pharmacy Administration Research (1) [Rpt./5] I II

611a-611b. Pharmacy and Its Environment (3-3) 1985-86: Social, behavioral, and organizational foundations of pharmacy, including the development of the present state of practice.

612a-612b. Issues in Pharmacy Practice

**Research** (3-3) 1990-91 Survey of research methodology for studying social and behavioral aspects of health care and pharmacy practice; strategy for selecting and modifying existing research tools for particular purposes.

621. Pharmaceutical Marketing (3) II Socioeconomic factors in the development, production, and distribution of drugs.

694. Practicum  
a. Clinical Clerkship (1-15) [Rpt./I] II  
b. Administrative Clerkship (1-15) [Rpt./I] II

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

800. Pharmacy Practice Project (1) I Individual pharmacy practice research not related to a thesis or dissertation. Open only to students enrolled in Doctor of Pharmacy program.

803. Pharmacy Clinical Clerkship  
a. Community Pharmacy Practice (5) [Rpt./10 units] I II S P, 461.  
b. Institutional Pharmacy Practice (5) [Rpt./10 units] I II S P, 461.  
c. Ambulatory Pharmacy Practice (5) [Rpt./10 units] I II S P, 461.  
d. Outpatient Pharmacy Practice (5) [Rpt./10 units] I II S P, 461.  
e. Adult Acute Care Pharmacy Practice (5) [Rpt./10 units] I II S P, 461.  

Note: 803a-e are six-week courses.

810. Pharmacy Clerkship  
a. Internal Medicine (3-10) I II S P, 803b.  
b. Surgery (3-10) I II S P, 803b.  
d. Geriatrics/Gerontology (3-10) I II S P, 803b.  
e. Outpatient Practice (3-10) I II S P, 803b.  
f. Emergency Services (3-10) I II S P, 803b.  
g. Acute Care (3-10) I II S P, 803b.  
h. Clinical Pharmacokinetics (3-10) I II S P, 803b.  
i. Psychopharmacology/Neurology (3-10) I II S P, 803b.  

Note: 810a-i are six-week courses.

815. Pharmacy Subspecialty  
a. Hematology/Oncology (3-10) I II S P, CR, 10 units of 810.  
b. Cardiology (3-10) I II S P, CR, 10 units of 810.  
c. Pulmonary (3-10) I II S P, CR, 10 units of 810.  
d. Endocrine (3-10) I II S P, CR, 10 units of 810.  
e. GI/Reflux (3-10) I II S P, CR, 10 units of 810.  
f. Ob/Gyn/Neonatal (3-10) I II S P, CR, 10 units of 810.  
g. Infectious Disease (3-10) I II S P, CR, 10 units of 810.  
h. Rheumatology/Immunology (3-10) I II S P, CR, 10 units of 810.  
i. Dermatology (3-10) I II S P, CR, 10 units of 810.  
j. Vision Information/Toxicology (3-10) I II S P, CR, 10 units of 810.  
k. Administrative (3-10) I II S 15-30L, P, CR, 10 units of 810.  

Note: 815a-1 are six-week courses.

896. Seminar  
a. Pharmacy Practice (1) II

**Philosophy (PHIL)**

Social Sciences Building, Room 213  
(602) 621-3129

Associate Professors J. Christopher Maloney, Joseph T. Tolliver  
Assistant Professors Deborah Mathieu, Vann McGee, 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 applications, two letters of recommendation from philosophy instructors, GRE general aptitude scores, and a sample of their written philosophy work are required.

**Degrees**

Master of Arts: A student must demonstrate proficiency in logic, and in addition must pass at least one course in each of the following three areas: history of philosophy, metaphysics and epistemology, and moral philosophy. A final examination must be passed, based on a research paper in an area chosen by the student. The student's program of study is designed individually. No thesis is required.

Doctor of Philosophy: A student must pass two courses in each of the following four distribution areas: (1) logic (required), philosophy of language, and philosophy of science; (2) history of philosophy; (3) epistemology and metaphysics; and (4) moral, social, and legal philosophy. A substantial proportion of one's courses must be at the seminar level. Students must pass a qualifying exam, based on a research paper. In addition, a preliminary exam must be passed in areas of the student's choice, and a doctoral dissertation is required. Further details about requirements and procedures can be obtained from the department. Teaching assistantships are available for qualified students.  

503.** Foundations of Mathematics (3) II 1990-91 (Identical with Math. 503)**

512.** Readings in Greek Philosophy (3) (Rpt.) (Identical with Grk. 512)**

513.** Advanced Symbolic Logic (3) Propositional and quantificational logic. Metatheorems on consistency, independence, and completeness. Set theory, number theory, and model theory. Recursive function theory and Goedel's incompleteness theorem.**

514.** Advanced Modal 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.

516.** Philosophy of Mathematics (3) Problems at the foundations of geometry and set theory. Logicism, formalism, and intuitionism. Nominalism vs. realism. Epistemology of mathematics.**

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) Introductory course in linguistics. (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. P.
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, blamelessness and excuses.
533.* Aesthetics (3) Classical and contemporary theories of the aesthetic experience, form and content, meaning, problems in interpretation and criticism of works of art.
534.* Social and Political Philosophy (3) Fundamental concepts of politics: leading social and political theories such as anarchism, social contract, Marxism.
536.* Games and Decisions (3) Classical theory of subjective probability, utility, and rational choice, with applications to game theory and social welfare theory. P. Math. 119.
538a-538b.* Philosophy of Law (3-3) 538a: Nature and validity of law, law and morality, judicial reasoning, law and liberty. 538b: Problems about justice, compensation and contracts and torts and responsibility and punishment. (Identical with Pol. 538a-538b)
539.* Ethics and the News Media (3) (Identical with Jour. 539)
540.* Metaphysics (3) Topics include free will and determinism; causation; personal identity; necessity and essence; truth, realism and ontological
541.* Theory of Knowledge (3) Critical examination of some of the major problems concerning evidence, justification, knowledge, memory, perception, and inference
542.* Knowledge and Cognition (3) Issues in philosophy and the psychology of knowledge, with emphasis on cognitive mechanisms. Perception, memory, concepts, mental representation, problem-solving, reasoning and rationality.
543.* Knowledge and Styles of Argument (3) Social and interpersonal processes affecting the acquisition and diffusion of knowledge. Emphasis on philosophical perspectives, with interdisciplinary borrowings.
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 awareness.
553.* Minds and Machines (3) Philosophical problems arising from current work in artificial intelligence and cognitive psychology.
556.* Philosophy of Language (3) Survey of basic issues in the philosophy of language such as: speech acts, reference, meaning, logical
564. Formal Semantics (3) Introduction to model-theoretic investigations of natural language interpretation, including coordination, quantification, intensions, tense, aspect, and modality. (Identical with Ling. 564)
565.* Pragmatics (3) 1989-90 (Identical with Ling. 565)
567.* Frege and the Rise of Analytic Philosophy (3) The writings of Frege on logic, language, and mathematics and their influence on contemporary philosophical thought.
570.* Greek Philosophy (3) [Rpt./1] Topics in Greek philosophy. May be selected from the pre-Socratics, Socrates, Plato, Aristotle and post-Aristotelian philosophy. (Identical with Clas. 570)
571a-571b.* Rationalism and Empiricism (3-3) 571a: Rationalists of the 17th and 18th centuries: Descartes, Spinoza, Leibniz, and Kant. 571b: Empiricists of the 17th and 18th centuries: Locke, Berkeley, Hume.
573.* Natural Language Processing (3) II 1990-91 (Identical with Ling. 573)
"*May be convened with 400-level course.
596. Seminar (See Health-Related Professions)
597. Physical Education (See Health-Related Professions)

Physics (PHYS)

PAS Building, Room 232
(602) 621-6680


Associate Professors Adam S. Burrows, Ke-Chung Chen, Paul W. Koch, Sumit Mazumdar, Michael A. Shupe, Dan Stein, Douglas Touissant, Jay E. Treat (Emeritus), Assistant Professors Ina Sarcevic, Wing Y. Tam

The department offers programs leading to the Master of Science and the Doctor of Philosophy degrees in a major in physics. Some interdisciplinary programs such as chemical physics, and astrophysics are also available. Further work, including theses programs may be obtained from the department. In cooperation with the College of Education, the department also offers work leading to the Master of Science and 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; one semester of modern physics including quantum mechanics. All applicants must submit scores on the aptitude and advanced tests of the Graduate Record Examination.

A student 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. Those who pass the comprehensive examination 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 to an amount determined on an individual basis by the graduate advisor and the department has a whole semester of teaching 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 511, 515a or the equivalent, and 568. Also, the student must complete one of the following courses: (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 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 advisor. Each student must complete three of the following courses: 535, 551, 561, 581, 586, and 685. The preliminary examination will cover classical mechanics, electromagnetic theory, 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; those who have deficiencies may be required to take 695 until the preliminary examination is 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 to satisfy the 30 units of work, chosen in consultation with the graduate advisor, are required for the minor in physics. Proficiency in one foreign language is required. Information on methods of demonstrating proficiency must 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 advisor early in their graduate work.

Experimental research is conducted in the following areas: elementary particle physics, cosmic rays and space physics, solid state physics, atomic and molecular physics, nuclear physics, condensed matter 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, and other areas.
tivity, cosmology, astrophysics and nonequilibrium statistical mechanics. Prospective students are encouraged to contact the department for information about specific research programs, 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 assistantships and 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) ICDT Basic physics of the human body; the principles of mechanics, electricity, sound, light, and radiation as they apply to the body; interpretation of clinical findings based on atomic physics. P, 102b.

504. Introduction to Quantum Optics (3) II (Identical with Opt. 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, 41f.

512. Topology and Advanced Mechanics (3) II Modern topics in classical mechanics, including non-integrable phase space, non-integrable systems, stochastic behavior and applications to semi-classical quantum theory (P51). P, 511.


530. Introduction to Biophysics (2) ICDT Concepts and experimental techniques of molecular biophysics; physical properties of biopolymers; bonding and conformation; optical interactions, biomolecular transitions, physical and chemical properties of biological materials, and their application. P, 515b, 570b. P, 515b. (Identical with Micr. 531)

531. Biophysical Theory (2) II Physical concepts and theories describing molecular structure and function, molecular evolution, limits to structure, symmetry, oligomer and virus structure, organelle structure and function. (Identical with Micr. 531)

533. Physics Demonstrations (1-3) ICDT Introduction to teaching materials and laboratory demonstrations illustrating principles of classical and modern physics, with emphasis on innovative and aesthetically pleasing demonstrations. Advanced degree credit available for nonmajors only. P, 2 semesters of physics.

535. Advanced Atomic Physics (3) II 1990-91 Detailed theory of atomic structure, interactions of atoms with electromagnetic fields, electrons and ions; techniques for calculating unperturbed and perturbed energy levels, transition probabilities, and atomic interaction cross sections. P, 515b, 570b, 475b.

536. Applications of Introductory Quantum Theory (3) II ICDT Applications of quantum theory to molecules, atomic nuclei, elementary particles, and complex systems. P, 475b, 515b.

540a-540b. Atomic and Molecular Spectroscopy for Experimentalists (3-3) Experiments and 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, 515b or 330. P, 454a-540b.

542. Laser Physics (3) I (Identical with Opt. 543)

545. Experimental Physics 545a-545b-545c are three-semester lecture courses; none is prerequisite to another.

Part A: Introduction to Spectroscopy (1) II ICDT 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.

Part B: Experimental Acoustics (1) II ICDT Laboratory experiments with sound sources, noise, light, detection, swept frequency sources, sound level meters, filters, musical instrument recording, room acoustics. P, 110, 116, 121, or consult department before enrolling.

Part C: Experimental Microscopy, Light Scattering and Optics of Small Particles (1) II ICDT Laboratory experiments with microscopes and polarized scattered light to characterize small particles in optical faces, optical constants, lasers remote sensing. P, 110, 116, 121, or consult department before enrolling.

550. Introductory Quantum Physics (3) II ICDT Basic concepts of nuclear physics: structure and stability of nuclei; nuclear forces; stable systems; nuclear reactions; decay of unstable systems; nuclear radiation characteristics. P, 102b or 330, Math. 112b. (Identical with N.E.E. 550)

551. Nuclear Physics (3) I Theory of nuclear systems, including stability, decay, nuclear forces, scattering, reactions, structure, and internal energy of nuclei. P, CR, 570a or 570b.


556a-556b. Electromagnetics of Conducting Fluids and Plasmas (3-3) 1990-91 with emphasis on physical applications. P, 460, 556a-556b.

560. Introductory Solid-State Physics (3) II ICDT 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, 112b or 330.


570a-570b. Quantum Mechanics (3-3) Principles of quantum mechanics; wave 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.

572. Fundamentals of Mathematical Physics (3-3) CD T vector and tensor analysis; differential and integral equations; Green’s functions; variational techniques; linear operators; applications to classical and quantum physical problems. P, 410, Math. 254, CR, 416b.


580a-580b. Quantum Field Theory (3-3) 1990-91 Meaning of quantized fields; symmetry breaking; field theory; general properties of interactions and peculiarities of electrodynamics and gravity. P, 570b, 577a.

581. Elementary Particle Physics (3) II 1989-90 Production, interaction, and decay of mesons, baryons and leptons; high energy particles; particle classification and symmetries; theoretical interpretation. P, 436.

582. High Energy Astrophysics (3) (3) 1989-90 (Identical with Astr. 582)

583a-583b. Plasma Physics and Thermonuclear Physics (3-3) 583a: II 583b: I (Identical with N.E.E. 583a-583b)

585. Star Formation (1) [Rpt.] I 1990-91 Stellar pulsation, the solar atmosphere, solar seismology and long-term solar variability related to climate.

586. Techniques in Elementary Particle Physics (3) II 1990-91 Classification of elementary particles and their interactions with matter, relativistic kinematics, detectors, data acquisition techniques, statistical techniques, analysis of experiments, cosmology, astrophysics and nonequilibrium statistical mechanics. P, 579a and 579b.

589. Topics in Theoretical Astrophysics (3) [Rpt.] I Current topics in theoretical astrophysics in depth, with emphasis on the methodology and techniques of the theorist and the cross-disciplinary nature of astrophysics theory. Example subjects are nuclear astrophysics, hydrodynamics, transient phenomena, planetary and solar system, and the evolution of star clusters. (Identical with Astr. 589 and Phy.S. 589)

596. Seminar a. Current Problems in Molecular Biophysics (1) I (Identical with Micr. 596a)

b. The Physics of Thin Films (3) II P, 460.

643. Quantum Optics (3) II 1990-91 (Identical with Chem. 643)

685. Graduate Physics Laboratory (3) [Rpt.] I 1990-91 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.


b. Colloquium II (1) [Rpt.] I (Identical with Phys. 695b)

c. Colloquium II (1) [Rpt.] I (Identical with Phys. 695c)

Physiological Sciences

Arizona Health Sciences Center, Room 4104 (602) 626-6511

Committee on Physiological Sciences

Graduate Program Committee

Professors William H. Dantzler (Physiology), Chairperson, Eldon J. Braun (Physiology), Darrel E. Goll (Nutrition and Food Science), Robert W. Gore (Physiology), Joseph F. Gross (Chemical Engineering), Raphael Gruever (Physiology), David J. Hartshorne (Nutrition and Food Science), Paul C. Johnson (Physiology), Murray A. Katz (Internal Medicine), Otakar Koldovsky (Pediatrics), Richard J. Lemen (Pediatrics), Timothy G. Lohman (Exercise and Sport Sciences), Eugene Mor...
The interdepartmental Committee on Physiological Sciences offers graduate work leading to the Doctor of Philosophy degree in physiological sciences. Research training is an integral part of the Ph.D. program. The research areas of the faculty in the program include: cellular and transport mechanisms; circulation and respiration, including microcirculation; comparative physiology; endocrinology; exercise physiology; gastrointestinal physiology; muscle physiology; neural mechanisms; including motor control; 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, or an appropriate discipline. If an equivalent course is not available, 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 or readings in biology or zoology is advisable for physical science majors. The Graduate Record Examination major in physiological sciences. Research training is an integral part of the Ph.D. program. The research areas of the faculty in the program include: cellular and transport mechanisms; circulation and respiration, including microcirculation; comparative physiology; endocrinology; exercise physiology; gastrointestinal physiology; muscle physiology; neural mechanisms; including motor control; renal mechanisms; and reproductive and developmental mechanisms.

The specialized nature of the material and equipment required for courses given in the College of Medicine and the College of Veterinary Medicine 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, endocrinology, peripheral vascular physiology, gastrointestinal and developmental physiology, membrane transport processes in physiology, and cardiac physiology.

503. Cellular Physiology (4) I Fundamental responses of living organisms to environmental changes, by examining mechanisms which operate at the cellular level. Topics include organelle structure and function, transmembrane homeostasis and transport phenomena, excitability, intercellular and intracellular communication, cellular mobility, and nerve-muscle-synapse function. P. Chem. 103b, 104b, 241b, 243b. Phys. 102b. May be convened with 400-level course.

580. Human Physiology (4) II Principles of physiology with emphasis on the human; designed primarily for students in pharmacy and health related sciences. Open to pharmacy majors and others upon enrollment before enrollment. P. Chem. 243b, Math. 123, Phys. 102b, CR, 581. (Identical with Tox. 580)

581. Physiology Laboratory (1) Experience intended to reinforce principles of physiological mechanisms; designed primarily for students in pharmacy and health related sciences. Open to pharmacy majors; others should consult department before enrollment. P. Chem. 243b, Math. 123, Phys. 102b, CR, 581.

582. Topics in Neurodevelopment (2) II 1989-90 (Identical with Nsc. 582)

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

598. Principles of Systems Neurobiology (4) II (Identical with Nsc. 598)


b. Muscle Physiology (2) [Rpt./12 units] I II P. 503.

c. Endocrinology (2) [Rpt./12 units] I II P. 601.

d. Renal Physiology (2) [Rpt./12 units] I II P. 601.

e. Molecular and Cellular Excitability (2) [Rpt./12 units] I II P. 601, 602.

f. Peripheral Vascular Physiology (2) [Rpt./12 units] I II P. 601, 602.

g. Cardiovascular Transport (2) [Rpt./12 units] I II

h. Systems Neurophysiology (2) [Rpt./12 units] I II
i. Introduction to Computer in Physiology (2) [Rpt./12 units] I II

j. Introduction to the Neurosciences I (2) 1989-90 (Identical with Med. 595y which is home)

k. Introduction to the Neurosciences II (2) 1989-90 (Identical with Med. 595z which is home)

* Available as both 595 and 695

1. May be convened with 400-level course.

601. Systems Physiology (8) II Comprehensive coverage of systemic physiology with emphasis in the underlying principles of function. It provides an overview of systems level neurosciences and, in conjunction with 602 and 801, concludes with an integrative section. P. Chem. 103b, 104b, 241b, 243b. Phys. 102b. May enroll for credit in 601 or 602, but not both. Consult department before enrolling.

602. Systems Physiology for Neuroscience Students (7) II Comprehensive coverage of systemic physiology with emphasis on the underlying principles of function. Includes overview of cardiovascular, renal, respiratory, gastrointestinal, and endocrine physiology and concludes with an integrative section. Offered in conjunction with 601 and 601, P. Chem. 103b, 104b, 241b, 243b, Phys. 102b. May enroll for credit in 601 or 602, but not both. Consult department before enrolling.

605. Neurosciences (6) II (Identical with Anat. 605)

610. Research Methods in Physiology (1-3) [Rpt./10 units] I II Laboratory course providing students with an understanding of the types of research available in the department. (Maximum length is 8 weeks.) Consult with department before enrolling.

695. Colloquium a. Motor Control (2) [Rpt./8 units] II (Identical with Ex.S.S. 695a)

696. Seminar a. Physiology Series (1) [Rpt./3] I II Open to majors only.

b. Physiology: Preparation and Presentation (1) [Rpt.] I II Open to majors only. Consult with department before enrolling.

c. Physiology Open Forum (1) [Rpt./3 units] I II


801. Human Physiology (8) II

805. Neurosciences (6) II (Identical with Anat. 805)

891. Preceptorship a. Physiology (3-12) [Rpt./12 units]


b. Muscle Physiology (2) [Rpt./12 units] I II P. 503.

c. Endocrinology (2) [Rpt./12 units] I II
The Department of Planetary Sciences and the Lunar and Planetary Laboratory are active participants in many missions of the NASA space science program. The laboratory's Space Imagery Center contains one of the most extensive collections of lunar and planetary photography in the world, including Ranger, Surveyor, Orbiter, and Apollo photography of the lunar surface. All students and staff have access to the Mariner 10 imagery of Venus and Mercury; and Pioneer 10 and 11 and Voyager results for Jupiter and Saturn all of which are available to students for research purposes. Also available for student research are the facilities of the University of Arizona's observatories, including 154cm, 15m, and 0.7m reflectors in the Santa Catalina Mountains north of Tucson, and 229cm, 0.9m, and 0.5m reflectors on Kitt-Peak west of Tucson, as well as the Multiple Mirror Telescope on Mt. Hopkins, which is a joint project of the University of Arizona and the Smithsonian Astrophysical Observatory. Laboratory facilities for cosmochemistry and geochemistry include a scanning electron microscope, an experimental petrology laboratory, a radiocarbon separation laboratory, and a neutron activation analysis laboratory. The laboratory also has an ultra-modern digital image processing laboratory. A nuclear reactor located on campus and counting facilities in the Lunar and Planetary Laboratory are available for isotope research and activation analysis.

The University has a well-equipped computer center. The Lunar and Planetary Laboratory maintains a number of special-purpose computers which can be used interactively for such special applications as inversion of Fourier interferograms and reduction of data from various space programs, and other student research projects.


d. Renal Physiology (2) [Rpt./12 units] II P, 601/601-602.

e. Molecular and Cellular Excitability (2) [Rpt./12 units] II.

1. Introduction to Personal Computers in Physiology (2) [Rpt./12 units] II.

Planetary Sciences (PTYS)
Space Sciences Building, Room 325
(602) 621-6963
Associate Professor Robert B. Singer
Assistant Professors Jonathan L. Lurie, Timothy D. Swindle, William C. Tittermore

Associate Professor Robert B. Singer
Assistant Professors Jonathan L. Lurie, Timothy D. Swindle, William C. Tittermore

The department offers multidisciplinary programs leading to the Master of Science and the Doctor of Philosophy degrees with a major in planetary sciences. Areas of specialization include experimental, observational, and theoretical study of planets, atmo spheres, interiors of the planets and satellites; asteroid and cometary astronomy and physics; the surfaces of the moon, terrestrial planets, and outer planet satellites; meteoroids; solar science, problems of plasma physics associated with cosmic rays, the solar wind and its interaction with solar system bodies and problems associated with the formation of the solar system. Students admitted to the doctoral program only. In certain circumstances, however, the Master of Science degree may be an appropriate intermediate or terminal degree.

Applicants should have completed an undergraduate major in a natural science such as astronomy, atmospheric sciences, chemistry, geology, or physics. Applicants must submit scores on the aptitude and advanced (chemistry, physics, geosciences, or optical sciences) exams. The majority of the courses should be 500 level or above and a "B" average must be maintained.

Degrees
Master of Science: This program is available only in special circumstances. At least eighteen units in the major core program and a thesis suitable for publication are required.

Doctor of Philosophy: All students must complete the nuclear core program consisting of 505a-505b, 510, 517, and 554 (though exceptionally well-prepared students may have a portion of this requirement waived). An additional 12 units in the major core program must be completed in a specialized area of planetary sciences. A specified competence in a modern foreign language is required. Students are expected to complete all requirements for the degree within three to four years following successful completion of the preliminary examination.
The Committee on Planning offers graduate professional programs leading to the Master of Science degree with a major in planning. Concentrations are offered in the fields of policy and planning (Management and Policy; College of Business and Public Administration) and in regional planning (Geography; Faculty of Social and Behavioral Sciences). Additional concentrations currently under development are in community design (College of Architecture) and natural resources planning (School of Renewable Natural Resources). All students pursuing the Master's degree with a major in planning are required to complete a basic core program consisting of fifteen units. The core includes: Geog. 581, 584, 585, 593, 597, 605, 611, 620, 621, 654, 662, 665, 668, 694.

The concentration in policy and planning provides training for a variety of staff-level careers in state and local government. Competence in problem solving in the public sector is strengthened by combining analytic, computer, financial, and legal/political institutions for regional infrastructure and development planning. Students are involved in actual field applications and are exposed to professional and faculty expertise. Areas of specialization are land use and the environment, health care, services for the elderly and public facility planning. In addition to the basic core, students in the concentration in policy and planning must complete M.I.S. 501, 506, and 620.

The concentration in regional planning provides a strong grounding in location and spatial analysis, environmental behavior, and in legal/political institutions for regional infrastructure and development planning. Students are involved in actual field applications and are exposed to professional and faculty expertise. Areas of specialization are land use and the environment, regional planning, interdisciplinarity of courses with hands-on experience through workshops and field internships. Students are familiar with the basic core program consisting of fifteen units. The core includes: Geog. 581, 584, 585, 593, 597, 605, 611, 620, 621.

The department offers programs leading to the Master of Science and Doctor of Philosophy degrees with a major in plant pathology. Concentrations are available in bacteriology, mycology, nematology, virology, physiology of parasitism, genetics of pathogens, diseases of economically important plants and soilborne fungi.

Applicants should have a background in the botanical sciences and undergraduate credit in college algebra and trigonometry (calculus is also recommended), microbiology, genetics, physics, two years 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 Doctor's Degree/Doctor of Philosophy elsewhere in this catalog.


1. Plant Nematology (3) 1990-91 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.

1. Analytical Techniques for Phytopathological Research (4) Techniques, including chromatography, electrophoresis, spectroscopy, and immunology. 2R, 6L, P. 205.

1. Diagnosis and Control of Plant Disease: 1989-90 Comprehensive course designed to give students familiarity with diagnosis of plant diseases, with diagnostic techniques, and with plant disease control concepts. 3R, 3L. All-day field trips. P. 205.

1. Recent Techniques in Plant Pathology (3-3) Comprehensive study of fungi, including their morphology, function, classification, genetics, and ecological importance. 575b: Basidiomycetes and Fungi Imperfecti. 575b: Myxomycetes, Phycomycetes, and Ascomycetes. 2R, 3L, P. Ecol. 506.

1. Molecular Genetics of Plant Pathogens (2) 1990-91 Comprehensive study of fungi, including their genetics, ecology, and classification. P. Bioc. 460.


1. Plant Pathology (PLP) Forbides Building, Room 104 (620) 621-1828

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)

1. Assistant Professor Robert Itami (Landscape Architecture)
of Science degree with a major in plant protection.

The major was under review at the time of catalog editing. Prospective students should consult the College of Agriculture for further information.

Plant Sciences (PLS)

Forbes Building, Room 201
(602) 621-1977


Assistants Professors Kaoru Matsuda, Thomas McCoy

Assistant Professors Douglas A. Bailey, Janice M. Coons, Alan H. Goldstein, Frederick R. Helke, Charles F. Mancino, William B. Miller, John W. Moon, Karl Van Acker, David A. Paizkill, Dennis T. Ray, Steven E. Smith

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, plant physiology, and plant molecular biology.

Preference will be given to applicants with undergraduate majors in agriculture or biological sciences. Prospective applicants should consult the graduate coordinator, Department of Plant Sciences, for specific requirements in their major.

Applicants must submit scores from the Graduate Record Examination (GRE) for the General Test and the GRE Biology or Chemistry Tests. Three letters of recommendation from individuals in a position to assess the applicant's potential as a graduate student should be sent to the graduate coordinator, Department of Plant Sciences. The decision to require or waive the requirement for the master's thesis will be made by the Department after consideration of the student's preparation, proposed graduate program, and professional objectives.

Students in a non-thesis degree program must complete a minimum of 36 units of course work.

The Master of Science thesis requirement may be fulfilled by a student who is a senior author of a manuscript published or accepted for publication in a refereed professional journal approved by the graduate student's committee.

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. 6 units of plant sciences or biology.

506.* Aird Land Crop Ecology (3) I Physical and biotrophic environment of crops in relation to crop culture, production, and geographical distribution; relations among the human population, crop productivity, and man's environment. 2P. 100, 101.

509. Information Sources for Agricultural Scientists (1) I Information systems and retrieval techniques, with particular reference to computerization, abstracting, indexing, and bibliographic documentation. (Identical with L.S. 509).

510. Plant Molecular Biology (3) I 1990-91 I Application of the principles of genetics, botany and statistics to the improvement of plants. P. 312 or Ecol. 320, A.Ec. 539.

515.* Principles of Plant Breeding (3) 1 Application of the principles of genetics, botany and statistics to the improvement of plants. P. 312 or Ecol. 320, A.Ec. 539.
Richard Bootzin, Richard W. Coan, Lynn A.

Cooper (Cognitive Science); Terry C. Daniel,

George Domino, Merrill Garrett (Cognitive

Science), Sigmund Hisao, William H. Itelson,

Marvin W. Kafn, John F. Knifstrom, James E.

King, Rong W. Laming, Lynne-Ann Naiden

(Cognitive Science), Carl A. Ridley (Consumer

and Family Resources), Bruce D. Sales, Daniel L.

Schacter, Mary C. Wetzel, David B. Wexler

(Law), Lawrence Wheeler (Eumenius); Robert

L. Wein.

Associate Professors Harold S. Arkowitz, Wayne

R. Carroll, Jeff L. Greenberg, Lewis Hertz,

Alfred W. Kasnitz, Ronald H. Pool, Rosemary

A. Rossier, Linda Swisher (Speech and Human

Sciences), William H. Thewalt, Elizabeth

B. Yost.

Assistant Professor Varda Shoham Salomon

The department offers programs designed for

students seeking completion of the Doctor of

Philosophy degree with a major in psychology.

Concentrations are available in clinical psychology

(clinical neuropsychology, psychopathology,

and movement disorders), developmental psy-

chology (cognitive and developmental psy-

chology, cross-cultural psychology), cognitive

psychology (perception and attention, psy-

cholinguistics, cognitive neuropsychology,

environmental cognition), philosophy of

science (epistemology, natural language

philosophy), and law and policy (law and social

science, mental health policy).

The department will contact the department early to obtain departmental application materials since the deadline for receipt of completed materials is February 1. Applicants must submit three scores on the advanced graduate (psychology) test. Recent applicants, when choosing the level of science required, must consider the implications of the policy (law and social science). P. 370 and 6 units upper-division psychology, or graduate standing.

500. 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.

501. Body Chemistry and Behavior (3) I Biochemical compounds related to life and the role of nutrients and bioactive compounds in their interaction with behavior. P. 101, and 302 or 8 units of biological laboratory science.


503. Methods of Neural Psychological Testing and Research (3) I Group discussion, demonstrations and experiments on current topics in neuropsychology, Problems selected to permit students to integrate laboratory techniques, research literature, and anatomical and physiological knowledge with behavioral theory. P. 101, 255, 302.


507a. Statistical Methods in Psychological Research (3-3) 507a: Research design, application and analysis of variance, multiple comparisons, and computer techniques in psychological research. 507b: Selected methodological issues and multivariate methods in psychology, with coverage of a major application area. Only one may be counted toward major.

509. History of Psychological Theories and Research (3) II Development of psychology as a science; schools, systems, theories, major advances, famous investigators. Only one may be counted toward major.

510. Advanced Social Psychology (3) II Social psychology, with emphasis on theory and method. P. 255, 300.


512. Animal Learning (3) I Animal learning with emphasis on interspecies comparisons. P. 255.

514. Personality and Social Development (3) I Research and theory in developmental psychology with an emphasis on social cognition, social and emotional growth. P. 255, 313.

515. Cognitive Development (3) I Development to major theories, methods, and research findings associated with the development of cognition and intelligence. P. 255, 312.

516. Advanced Personality (3) I Advanced study of theories of personality; methods and results of personality study. P. 255, 316.


520. Neurobiology (3) I Recent advances in neurobiology, with a strong emphasis on cellular and molecular mechanisms of behavior and development. P. 255, 316.

521. Psychology of Death and Loss (3) I Basic concepts in a psychology of death and loss, with an emphasis on the adjustment to death and loss, and the underlying phenomena. P. 255, 316.

522. Psychobiology (3) I Recent advances in psychobiology, with a strong emphasis on cellular and molecular mechanisms of behavior and development. P. 255, 316.

524. Animal Behavior (3) I Recent advances in the study of behavior from an ethological/evolutionary perspective. P. 255.

527. Field Methods in Environmental Psychology (3) I 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. 303, 306, 6 units of graduate standing. (Identical with Arch. 527 and L. Ar. 527).

528. Cognitive Neuroscience (3) I Recent advances in analysis of the neural basis of behavior, such as learning, memory, and thinking. P. 255, 303, 306, 6 units of social science, or graduate standing. 530a. Psychology, Law and Social Policy (3) I Critical review of theory, methods and research in the psychology, law and social policy interface. P. 255, 303, 306, 6 units upper-division psychology; or graduate standing.

530b. Psychology, Law and Social Policy (3) I Critical review of theory, methods and research in the psychology, law and social policy interface. P. 255, 303, 306, 6 units upper-division psychology; or graduate standing.

535. Psychological Problems of the Aged (3) I In-depth study of the major psychological problems of the aged. P. 255, 303, 306, 6 units of social science, or graduate standing.


540a. Psychology, Law and Social Policy (3) I Critical review of theory, methods and research in the psychology, law and social policy interface. P. 255, 303, 306, 6 units upper-division psychology; or graduate standing.

542. Psycholinguistics (3) I Recent advances in the area of psycholinguistics, with an emphasis on sentence processing and the contribution of linguistic theory to an understanding of psycholinguistic mechanisms. P. 255, 303, 306, 6 units of upper-division psychology; or graduate standing.

544. Cognitive Neuropsychology (3) I Recent advances in the area of cognitive neuropsychology, with an emphasis on the contribution of the brain to cognitive activities including memory, thinking, learning, and perception. P. 255, 303, 306, 6 units of upper-division psychology; or graduate standing.

546. Environmental Cognition (3) I Recent advances in the area of environmental cognition, with an emphasis on cognitive aspects of environmental psychology. P. 255, 303, 306, 6 units of upper-division psychology; or graduate standing.
The School of Public Administration and Policy
(See Public Administration and Policy)

Public Administration (See Public Administration and Policy)

Public Administration and Policy
Harvill Building, Room 453
(602) 621-7965

Professors Michael Gottfredson (Management and Policy), Psychology), Helen Ingram (Political Science), Theodore Koff (Management and Policy), John Schwarz (Political Science), Lee Sigelman (Political Science), Arthur Silvers (Management and Policy)

Associate Professors H. Brinton Milward, Director, Victor R. Baker (Geosciences), Benjamin N. Herman (Atmospheric Sciences), Donald F. Post (Soil and Water Science), John A. Reagan (Electrical and Computer Engineering), Richard W. Reeves (Geography and Regional Development), Charles E. Glass (Mineral and Geological Engineering), John W. Olsen (Anthropology), William O. Rasmussen (Agricultural Engineering), Robert A. Schoongerdt (Electrical and Computer Engineering; Arid Lands Resource Sciences)

Assistant Professor Alfredo R. Huete (Soil and Water Science)

The School of Public Administration and Policy offers the Master of Public Administration degree. The program is designed to prepare men and women for positions of leadership in public sector and nonprofit organizations, as well as private organizations dealing with the public sector. Graduates may expect to pursue management or policy making careers in a wide variety of settings within organizations at local, state, national, and international levels.

For admission and degree requirements, please see Master of Public Administration elsewhere in this catalog.

Public Management (See Management and Policy)

Public Policy, Planning and Administration (See Management and Policy)

Range Management (See Renewable Natural Resources)

Reading (See Education)

Real Estate (See Finance and Real Estate)

Regional Development (See Geography and Regional Development)

Rehabilitation (See Education)

Reliability Engineering (See Systems and Industrial Engineering)

Remote Sensing (REM)
1002 N. Warren Avenue, Room A17
(602) 621-4242

Committee on Remote Sensing (Graduate)

Professors Philip N. Slater (Optical Sciences), Chairperson, Victor R. Baker (Geosciences), Dinshaw N. Contractor (Civil Engineering), Benjamin N. Herman (Atmospheric Sciences), Donald F. Post (Soil and Water Science), John A. Reagan (Electrical and Computer Engineering), Richard W. Reeves (Geography and Regional Development), Charles E. Glass (Mineral and Geological Engineering), John W. Olsen (Anthropology), William O. Rasmussen (Agricultural Engineering), Robert A. Schoongerdt (Electrical and Computer Engineering; Arid Lands Resource Sciences)

Assistant Professor Alfredo R. Huete (Soil and Water Science)

Remote sensing concerns the collection of information related in some way to the earth's natural resources or environment. Data are primarily collected by satellite and aircraft systems in conjunction with localized ground-based surveys and measurements. The data are processed by digital computer or optical techniques to extract information of value to earth scientists and resource and environment managers at the local, state, and federal levels.

The Committee on Remote Sensing offers no graduate major at the present time but minor programs are available for doctoral students with majors in disciplines within the Colleges of Agriculture, Business and Public Administration, Engineering 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 Ws.M. 520. The remaining units may be selected from Ws.M. 622, C.E. 554, Geog. 583, or G.En. 507.

Students electing the emphasis in techniques of remote sensing must complete twelve graduate units including Opti. 550 and E.C.E. 531.

The remaining units may be selected from Opti. 524, 539, 558, 559, 567, Atmo. 561, 656a-656b, 658.

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.

596. Seminar
a. Remote Sensing (1) II 1990-91

Renewable Natural Resources (RNR/LAR/RAM/WSM/WESC/NRR)

Biological Sciences East, Room 325
(602) 621-7255


Associate Professors Stanley K. Bricker, Paul R. Krausman, Gordon S. Lehman, William Mannan, William J. Matter, Virgil W. Shaw, E....Lamar Smith, Jerry C. Tash, Donovan C. Wilkin

Assistant Professors Robert M. Itami, Ann M. Lynch, Mitchel P. McClaran, E. Gregory McPherson, Bruce A. Poundy, Frank W. Telewski (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 Doctor'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 management in the area of 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 water resources, 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 for-
597. Workshop
  a. Natural Resource Conservation Workshops (Rpt.) II I S
  b. *Desert Ecosystems (1) [Rpt.] III S

696. Seminar
  a. Renewable Natural Resources (1-2) [Rpt.] II
  b. Landscape Resources
    Ervin H. Zube, Program Leader

Landscape Architecture (LAR)

501. Urban/Rural Landscape Planning and Design (4) I Planning and design problems at the urban/rural interface; issues of growth and change, land use patterns, and regional systems. Field trips. 2R: 1989-90

502. Regional Landscape Planning and Design (4) II Planning and design problems of regional scope and emphasis. 1H, BL, P. 401.

507. The American Landscape (3) II (Identical with Geo. 507)

522a. Advanced Landscape Design (4-4) II 1990-91 Advanced techniques in urban landscape design which are directed toward the greater metropolitan area, with special attention to the urban-nonurban fringe and to urban and regional systems. Field trips. P, 456: 1989-90

523a. Advanced Landscape Planning (4-4) I 1990-91 Advanced techniques in landscape planning and problem analysis, mapping, and computer applications. Field trips. 523b: 1989-90 Advanced techniques in rural landscape planning and problem analysis including applications of research in prevention and behavior. 2R, 6L. Field trips. 523a is not prerequisite to 522b.


524. Landscape Planning (2) I Theories and models in landscape planning; planning issues, methods, and case studies. 1989-90

536. Urban Forestry (2) II 1989-90 (Identical with Ws. M. 536)

542. Landscape Planning and Landscape Architecture (3) I Examination of the historical background and theoretical basis of landscape architecture. 1990-91

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, 6L, P. 451.

560. Professional Practice (3) I Professional services, contract documents, contract administration, organization, ethics, professional registration, roles of the landscape architect, the practice of landscape architecture. P. 501.

586. Seminar
  a. Rangeland Management (1) [Rpt.] II
  b. Forest-Watershed Resources
    Gordon S. Lehman, Program Leader

Watershed Management (WSM)


508. Wildland Fire Management (3) I Principles of fire behavior in forest, range and other vegetation types; the ecological, economic, and social impacts of fire in the environment; the relationships of fuels, weather, and topography; the design and application of fire suppression and control techniques; fire management. P. 460, 462.
510.* Silviculture (3) II Principles and technical procedures for reproducing, planting, and tending forest crops, with reference to watershed management, including silvicultural principles applied to planimetric and topographic mapping. 3L. P or CR 522.

520.* Photogrammetry (1) II 1990-91 Aerial photographic planning for natural resource management; biophysical and socio-economic issues related to the development of forest commodities and amenities. P, 6 units of upper-division work in forestry.

525.* Wood Products (2) II 1990-91 Harvesting, processing, and marketing of wood products.

530.* Forest Resource Management (1) Decision making in the management of forest lands. 3R, 3L. P, 440, 510, 515.

531. Dryland Forest Management (3) II 1990-91 Utilization and management of forest resources in dry environments; biophysical and socio-economic issues related to the development of forest commodities and amenities. P, 6 units of upper-division work in forestry.

532. Agroforestry (3) I 1989-90 Ecological and socioeconomic factors related to the planning and implementation of agroforestry systems. P, 6 units of upper-division watershed management.


534. Nursery and Plantation Management (3) I 1990-91 Tree nursery and forest plantation establishment and management, with emphasis on dryland ecosystems. P, 6 units of upper-division watershed management.

535. Water Management in Dryland Ecosystems (3) I Hydrologic principles as applied to arid and semiarid ecosystems with water management application in dryland resources management. P, A.Ec. 539, S.W. 201.

536. Urban Forestry (2) II 1989-90 Principles and practices of urban forestry, including vegetative structure and function, inventory and evaluation techniques, and planning approaches. (Identical with L.Art 536)


556. Quantitative Dendrochronology (3) I 1990-91 (Identical with Geos.556) 

560.* Watershed Hydrology (3) I Application of fundamental principles to quantifying the basic hydrologic processes occurring on watersheds. P, Geos. 100a; S.W. 200, 201, Math. 160. (Identical with Hyd. 560)

562.* Watershed Management (3) II Evaluating hydrologic impacts of management activities on watersheds to include silviculture, range, mining, and recreation use. P, Geos. 100a; S.W. 200; Math. 160.

563. Plant-Water Relations (3) II (Identical with M.C.B. 563)

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

565. Hydrochemistry (3) II 1989-90 (Identical with S.W. 565)

566. Botanical Basis of Dendrochronology (3) I 1989-90 (Identical with Geos. 566)

571.* Water Quality Control (3) II (Identical with C.E. 571)

576. Advanced Natural Resource Economics (3) I (Identical with A.Ec. 576)
579a-579b. Problems of Teaching Russian (3) Survey of modern methods of language teaching, with emphasis on the particular problems presented by Russian. All teaching assistants must be enrolled in this course while teaching Russian. Minimum of two units will be counted toward Master's degree requirements.

581. Russian Phonology and Morphology (3) I II P. 301b or 305b.

583. History of the Russian Language (3) I P, 301b or 305b.

585. Linguistic and Computer-assisted Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585)

586. Russian Drama (3) Examination of the major plays and playwrights of nineteenth- and twentieth-century Russian playwrights. P. 405b.

596. Seminar
   a. Russian Literature: 18th Century (3)
   b. Russian Literature: 19th Century (3)
   c. Russian Literature: 20th Century (3)

Secondary Education (See Education)

Sociology (SOC)

Social Sciences Building, Room 400
(602) 621-3531


Associate Professors Douglas J. MacAdam, Head; James T. Borhek, Courtney B. Cletand, Roberto Fernandez, Pat D. Fligstein, Patricia L. MacCorquodale, Jerry L. L. Miller, Walter W. Powell

Assistant Professors Roberto M. Fernandez, Debra Friedman, Joseph R. Hambenne (Emeritus), Kathleen C. Schwartzman, James Shockey

The department offers programs leading to the Master of Arts and the Doctor of Philosophy degrees with a major in sociology. A brochure describing these programs is available from the Sociology Department, Social Sciences Building, Room 400.

Potential applicants are urged to include strong courses in theory, methodology, and statistics in the undergraduate program. Applicants must submit scores on the aptitude test of the Graduate Record Examination and two letters of recommendation. The graduate record must show an average grade of "B" or higher in sociology and in all work completed during the last two years of college study. The average grade for all undergraduate work must be at least "B-" and, unless the student has a very strong undergraduate record, the student's scores on the Graduate Record Examination, both quantitative and verbal portions, must be very high. Applications must be received by January 15 if financial assistance for the following semester is desired.

Degrees

Master of Arts: For the master's degree, thirty units of credit for 500-level courses (these open to graduate students only), excluding independent study and including the following courses: 500a-500b, 507a-507b, 575; and three to six units of research seminar. For students who terminate their study at this institution, a data-analysis paper must be submitted. Both require a final oral examination. There is no language requirement for the M.A.

Doctor of Philosophy: For the Ph.D., a minimum of thirty units of coursework, including eighteen units of dissertation and the minor, are required. All students are required to complete the statistics, methods, theory, and research seminar requirements set forth above for the M.A. In addition, students are expected to complete two of the following courses: 505, 510, 525, 530, 541, or 550, and two of the following: 522, 560, 580, 596. Written preliminary examinations must be 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.

500a-500b. Sociological Theory (3-3) 500a: Classic theory: Marx, Weber, Durkheim. 500b: Modern theory: Chicago School, symbolic interaction (15 units, including 583 or 584). P. 500a or consult department.

503. Sociosomatics (3) I II Social control of bodily process and structure, including social determinants of health. Both macro and sociopsychological and statistical research literature. P. upper-division standing and 3 units of social science or consult department before enrollment.

504. Sociology of the Southwest (3) I Populations, cultures, and social problems in their regional setting, with emphasis on the Southwest. P. 100 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 504, A.In.S. 504 and M.A.S. 504)

505. World-System Theory and Research (3) I II 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)

510. Advanced Social Theory (3) Basic approaches in political sociology, with emphasis on the relationship of economic and political processes.

515. Social Movements and Collective Action (3) III 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 works 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 relationships to the individual and society. P. 9 units of sociology. (Identical with Anth. 522)

525. Intermediate Complex Organizations (3) Basic review of classic and contemporary approaches to the study of complex organizations; formation, development, and internal processes. (Identical with M.A.P. 525)

526. Cross-National Research Methods (3) II Introduction to the logic and methods of cross-national social research. (Identical with Pol. 526)

530. Graduate Social Psychology (3) Basic study of classic and contemporary approaches to social psychology, with particular reference to socialization and the relationship between the individual and social structure.

531. Kinship and Social Organization (3) II (Identical with Anth. 531)

535. Public Opinion and Voting Behavior (3) I (Identical with Pol. 535)

536. Social Structure and Personality (3) II Relationship between the person and the group. Social factors in character formation. P. 9 units of sociology.

541. Deviance and Social Control (3) Basic critical review of traditional and contemporary concepts of deviance, deviant behavior, and social control; evaluation of contemporary research bearing upon deviance theory and informal and formal mechanisms of social control. P. 201 or 304.

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

550. Social Stratification (3) I II Theories of social class, caste, and rank; social mobility in contemporary society. (Identical with Anth. 550)

551. Stratification and Class (3) Basic examination of concepts and research in the area of stratification, with emphasis on the classic statements and contemporary research.

559. Sociology of Gender (3) II Social construction, variation and consequences of gender categories across time and space. Topical (identity-making, deviance and institutional, family, religion, politics) approaches. P. 100 or consult department before enrollment.

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. 100 or 301; 6 additional units of sociology or anthropology. (Identical with Anth. 567, A.In.S. 567 and M.A.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).

575. Advanced Social Research Methods (3) Nature and execution of social research; experimental design, factorial designs, data collection, techniques of analysis and interpretation. 2R, 3L, P. 375b.

580. Population Studies (3) I Theory and research in the fields of fertility, mortality, and migration, with emphasis on their relationships to social structure. An original research project is required.

585. Advanced Sociological Theory (3) Sociological theories as alternative explanations of empirical data and models, 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)

595. Colloquia
   a. Introduction to Graduate Study (1)

596. Seminar
   a. Advanced Problems in Research (1-3) [Rpt./1]
   b. Graduate Teaching (3) I II 1990-91 2R, 3L.
   c. Advanced Problems in Deviant Behavior (1-3) II
545. Microbiology of the Rhizosphere (2) II 1990-91 Influence of plant roots on soil microorganisms via the rhizosphere. Interaction between soil organisms and roots and rhizosphere dynamics. P. 435 or Micr. 425. (Identical with Micr. 545).


Post

560. Hydrochemistry (3) II 1899-90 Solute composition of naturally-occurring waters, chemical reactions affecting the solute content of water, relations and effects of above on water quality criteria and pollution, analytical procedures for water-testing laboratories. 2R. 3L. P. Chem. 322 or C.E. or 471. (Identical with W.M. 565) Dutt

570. Soil Physics (3) II CDT Soil structure and physical constitution of soils; the physical properties of soils, systems, principles of soil moisture and exchange of gases in the soil, and physical laws governing the movement and availability of soil water. 2R. 3L. P. 200, Phys. 102b. CH, Math. 125a. Warrick

589. Practicum


696. Seminar

a. Soils, Water and Agricultural Engineering (1) [Rpt./I] II (Identical with A.En. 696a)

Southwest Studies

Southwest studies are designed to bring new perspectives to regional subjects through an interdisciplinary approach. Courses on the Southwest will be offered in the following 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/Master of Education elsewhere in this catalog. Through the graduate Committee on Medieval Studies, the department assists graduate students 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. Hispantic 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 credit 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) II 1990-91 Historical survey of theoretical writings on literature, with their implications for practical criticism.


503. Introduction to Medieval Studies (3) II 1990-91 Historical, social, and cultural currents as background for the analysis of medieval Hispanic letters.

504. Thirteenth Century Spanish Literature (3) II 1990-91 Historical, critical, and textual study of a prose volume. P. 503.

505. Advanced Composition and Conversation (3) I II Study and practice in formal-discussion and expository writing. P. 330.

506. Fifteenth Century Spanish Literature (3) II 1990-91 Traditional courtly and satirical literature; the Celestina. P. 503.
508. Golden Age Theater II: Lope de Vega and His School (3) I 1990-91 The drama at apogee, principally in the plays of Lope de Vega and of Tirso de Molina. P. 400a.


510. Hispanic Renaissance Poetry (3) II 1989-90 Renaissance poets of Spain and the New World. P. 400a or 401a.


513. Golden Age Prose II: The Counter-Reformation (3) I 1990-91 Chivalric, sentimental, pastoral and early picaresque fiction, plus the major works of the Golden... P. 400a.

514.* Teaching of Modern Languages (3) II (Identical with T.T.E. 514).

515.* Creative Writing in Spanish (3) II Practice in writing poetry and fiction in Spanish. P. 400a.


517. Hispanic Prose of the Enlightenment (3) II 1990-91 Prose writers of the Neoclassical Period in Spain and the New World. P. 400b or 401b.

518. Realism and Naturalism (3) II 1990-91 Major prose writers of the 19th century from Galdós to Blasco Ibáñez.

521. The Generation of '86 (3) I 1989-90 Major literary expressions concerning the problems of Spain and the Spanish from the late 19th to the early 20th century.

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 Fr. 522).

523a-523b.* Theory of Spanish Syntax (3-3)

523c: Introduction to current theories of syntax to describe specific phenomena. 523b: More detailed and ranging analysis of Spanish grammar within the general theory. (Identical with Ling. 523a-523b).

524. Contemporary Spanish Novel (3) I 1990-91 The novel since the Civil War. P. 400b.

525. Contemporary Spanish Poetry II 1989-90

526. Contemporary Spanish Drama (3) II 1990-91 Major Spanish theatrical trends from the Civil War (1936-39) to the present. P. 400b.

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 1989-90 Spanish-American works in the baroque or manerista literary current from the seventeenth and eighteenth centuries, largely in Mexico. P. 400a.

529. Colonial Hispanic American Theatre (3) II 1990-90 Masterworks of the theatre in Hispanic America from sixteenth century to Independence. P. 401a.


532.* Pre-Columbian Culture and Myths (3) II 1990-91 Cultural development of Aztec, Mayan, and Incan civilizations and their artistic and mythic expression. P. 320.


535.* Cervantes' Don Quixote (3) II P. 320.


537. Pre-Columbian Literature (3) I 1989-90 Major works by Spanish-American dramatists from Independence to the present. P. 401b.


541.* Mexican-American Poetry (3) I 1990-91 Major works (Spanish and bilingual) in contemporary Mexican-American/Chicano poetry, from 1960s to date. P. 320.


545.* Novel of the Mexican Revolution (3) I How the revolution of 1910 has been portrayed by Mexican-American writers. P. 320.


547. Contemporary Mexican Literature (3) II S. Mexican novelists, 1960s-90s. Mexico; their works, narrative perspective, characterization, language, time, space, and themes. P. 320.


550.* Spanish-American Short Story (3) S Development of the modern short story in Latin America, with examples from various countries and authors. Offered in Guadalajara only. P. five semesters of college Spanish.


571. Hispanic-American Short Story (3) I 1989-90 Masterworks of the short story in Hispanic-America during the twentieth century. P. 401b.


574. Spanish for the Bilingual 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.

574. Spanish-American Essay (3) II 1990-91 Major essays from Independence to the present.

575a-575b.* Spanish-American Novel of the Twentieth Century (3-3) 575a: The 1920s. 575b: From 1930 to 1960. 575c: From 1960 to the present. Neither semester in this sequence is prerequisite to any other. P. 401b.

575. Spanish-American Theater: Nineteenth and Twentieth Century (3) II 1989-90 Contemporary authors and trends in Spanish-American poetry, mostly from the 1940s to the present. P. 401b.

585.* Linguistic and Computer-aided Approaches to Literature (3) [Rpt./6 units] II (Identical with Ger. 585).

596. Seminar b. Methods of Literary Research (3) I 1990-90

m. Southwest Bibliography (3) [Rpt./6 units] I (Identical with Hist. 596m, which is home).

620. History of the Spanish Language (3) 1989-90

621. Spanish in the Americas (3) I 1990-91

779a-779b. Techniques of Teaching College Spanish (1-3 — 1-3) 779a: Theories of second language acquisition and teaching. 779b: Theories of second language evaluation. Units cannot be used to satisfy departmental graduate degree requirements.

696. Seminar a. Philology and Linguistics (3) II

b. Spanish Literature (3) II

c. Spanish American Literature (3) II

Portuguese (PORT)

549.* Brazilian Literature in Film (3) I 1990-91 The masterpieces of Brazilian literature and the great films based upon them. P. 301a-301b.

*May be counted with 400-level course.

596. Seminar m. Southwest Bibliography (3) [Rpt./6 units] I (Identical with Hist. 596m, which is home)

696. Seminar a. Portuguese Literature (3) [Rpt./6 units] II

b. Brazilian Literature: 16th-18th Centuries (3) III

h. Brazilian Literature: 19th Century (3) III

i. Brazilian Literature: 20th Century (3) III

Special Education (See Education)
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 thirty or thirty-three units. For the thirty-unit program, at least eighteen must be taken within the department. Additional master's level options are available, including a six-unit thesis, a six-unit paper, or a three-unit report, each of which requires an oral examination. The thirty-three-unit program course work, subject to the stipulations above, may be supplemented by 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 from the department.

For the Master of Science degree, at least 18 units must be taken from the Department of Industrial Systems and Management, subject to the stipulations above, with 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 from the department.


502. Reliability Testing (3) I (Identical with A.M.E. 508)

503. Risk Estimation and Evaluation (3) I (Identical with W.R.A. 513)

504. Reliability Engineering (3) I (Identical with A.M.E. 513)


509. Probability and Statistics (3) I (Identical with A.M.E. 508)


511. Mathematical System Theory (3) II (Identical with A.M.E. 528)


514. Linear and Integer Programming (3) I Topics include linear and integer programming formulations, simplex method, geometry of the line, sensitivity and duality theory, projective transformation methods, network flow problems, branch and bound algorithms, cutting plane algorithms, Lagrangian relaxation methods. P. 540.


516. Theory of Probability (3) I (Identical with Math. 564)

517. Mathematical Statistics (3) I Standard and nonparametric one- and two-sample procedures, ANOVA designs, linear and multiple regression, correlation, probability, moment-generating functions, and contingency tables. 3R, 3L. Not open to majors. P. two semesters of calculus. (Identical with Math. 566)

518. Reliability Testing (3) I (Identical with Math. 566)

519. Linear and Integer Programming (3) I Topics include linear and integer programming formulations, simplex method, geometry of the line, sensitivity and duality theory, projective transformation methods, network flow problems, branch and bound algorithms, cutting plane algorithms, Lagrangian relaxation methods. P. 540.


521. Statistical Methods (3) I In-depth study of a selected body of statistical techniques. Consult department for current course content. P. 466.

522. Linear and Integer Programming (3) I Topics include linear and integer programming formulations, simplex method, geometry of the line, sensitivity and duality theory, projective transformation methods, network flow problems, branch and bound algorithms, cutting plane algorithms, Lagrangian relaxation methods. P. 540.

523. Mathematical System Theory (3) II Mathematical theory of discrete systems and models for application to large-scale, complex, machine systems.

524. Finite State Machines in Water Resources Management (3) II Design of finite state machines and water resources management systems. P. 550.


526. Mathematical System Theory (3) I Mathematical theory of discrete systems and models for application to large-scale, complex, machine systems.


529. Mathematical System Theory (3) I Mathematical theory of discrete systems and models for application to large-scale, complex, machine systems.


533. Experimental Design for Engineering II (3) II Continuation of 532. Topics include fixed and random effects models, confounding, fractional factorials, nested designs and response surface methodology. P. 536.

534. Dynamic Programming (3) I Application of the art and theory of dynamic programming to common stochastic and deterministic sequential decision problems, including equipment replacement, capacity expansion, inventory control and decision analysis. P. 321, 330.

535. Linear and Integer Programming (3) I Topics include linear and integer programming formulations, simplex method, geometry of the line, sensitivity and duality theory, projective transformation methods, network flow problems, branch and bound algorithms, cutting plane algorithms, Lagrangian relaxation methods. P. 540.

536. Algorithms and Heuristics for Graphs and Networks (3) II State-of-the-art solution methods for several practical problems that may be formulated on graphs and networks. Emphasis on obtaining good solutions in reasonable time when optimization proves intractable. P. 544.

537. Theory of Probability (3) I (Identical with Math. 564)

538. Mathematical Statistics (3) I Standard and nonparametric one- and two-sample procedures, ANOVA designs, linear and multiple regression, correlation, probability, moment-generating functions, and contingency tables. 3R, 3L. Not open to majors. P. two semesters of calculus. (Identical with Math. 566)

539. Linear and Integer Programming (3) I Topics include linear and integer programming formulations, simplex method, geometry of the line, sensitivity and duality theory, projective transformation methods, network flow problems, branch and bound algorithms, cutting plane algorithms, Lagrangian relaxation methods. P. 540.
include aggregate production planning, capacity planning, inventory control and flexible manufacturing. P. 921, 923, 925.


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. P. Familiarity with computers.

575. Computational Methods for Games, Decisions, and Artificial Intelligence (3) II An introduction to automata, computer representation and optimal solution of games and decision problems. Principles of heuristic programming and machine learning. A programming project is to be selected from areas such as game strategies, graphics, recreational mathematics, and manufacturing simulation. Microcomputer experience is emphasized. P. 270 or C.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 information requirements and data management. Includes CAD, CAM, CAPP, real time scheduling, networking and system justification.

584. Manufacturing Automation (3) II Current topics in hardware for automation, selecting and implementing robots, part orientation, computer vision, automated warehousing and material handling, programmable controllers, NC machining, on-line computer control. Laboratory projects.

585. Introduction to Robotics (3) I A study of the principles involved in the operation and design of robots, including homogeneous transformations, kinematics, trajectory selection, dynamics, control and sensing. P. 350.

586. Modelling Systems (3) II An intermediate-level introduction to topics in hierarchical design, planning and control of manufacturing systems and their applications. Topics include modeling automated transfer lines, cellular manufacturing, and flexible manufacturing systems. Attention will be given to the performance of manufacturing systems and operational issues such as the role of robots, flexible machines, computers, and material handling systems. P. 321, 340.

590-500. Animal Anatomy and Physiology (3-5) Physiology, gross and comparative anatomy. 500a: Nervous, musculoskeletal, immune, hemolymphatic, circulatory, and renal systems. 500b: Respiratory, digestive, endocrine and reproductive systems. 500a is a prerequisite to 500b. P. 431 or M.S. 521a or 521b.

644. Numerical Methods for Nonlinear Programming (3) II Unconstrained and constrained optimization problems from a numerical standpoint. Topics include variational methods, quadratic programming, active set methods, penalty function methods and successive quadratic programming methods. P. 544.

645. Large-Scale Optimization (3) I 1990-91 Decomposition-coordination algorithms for large-scale mathematical programming. Methods include generalized Benders decomposition, surrogate and price directive methods, subgradient optimization, and descent methods of nondifferentiable optimization. Application of these methods to stochastic programming will be emphasized. P. 564.

650. Mathematical Theory of System Design (3) II Rigorous development of the tricyleton theory of system design. P. 554.

685. Advanced Topics in Robotics (3) II Select topics covering recent advances in robotics, to be chosen from a list including applications, kinematics, dynamics, tactile sensing and vision. P. 485.

695. Colloquium a. Motor Control (2) [Rpt./8 units] II (Identical with Ex.S.S. 695a)

Teaching and Teacher Education (See Education)

Toxicology (See Pharmacology and Toxicology, College of Pharmacy)

Urban Planning (See Planning)

Veterinary Science (VSC)

Pharmacy-Microbiology Building, Room 202 (602) 621-4466


No advanced degree is offered in veterinary science. Cooperative arrangements will be made with the departments of Entomology, Ecology and Evolutionary Biology, or Microbiology and Immunology for students pursuing advanced degrees in these areas. Students majoring in other disciplines may elect veterinary science as a doctoral minor with the approval of the major department.

500a-500b. Animal Anatomy and Physiology (3) Physiology, gross and comparative anatomy. 500a: Nervous, musculoskeletal, immune, hemolymphatic, circulatory, and renal systems. 500b: Respiratory, digestive, endocrine and reproductive systems. 500a is a prerequisite to 500b. P. Ecol. 181, 182; Chem. 243a; Math. 117R/S.

503R. Biology of Animal Parasites (3) I Biology of host-parasite relationships with emphasis on parasites of veterinary and human importance. Parasite morphology and physiology, life cycles, epidemiology, pathogenesis and zoonotic potential. P. 8 units of biology or medical parasitology (Identical with Ento. 503R, Ecol. 503R and Micr. 503R)

503L. Parasitology Laboratory (1) I Parasite morphology and diagnostic laboratory techniques. P. 9 units of biology or medical parasitology. CR, 403R. (Identical with Ecol. 503L, Ento. 503L and Micr. 503L)

505. Animal Diseases (3) I Integration of management, husbandry, and preventive veterinary medicine, as related to animal diseases.

520R. 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) I Gross and histologic changes occurring in tissues and organs in selected human and animal diseases and disease processes. P, or CR, 423R. (Identical with Micr. 523L and Tox. 523L)

538. Ecology of Infectious Disease (3) II 1990-91 (Identical with Micr. 538)

550. Medical Mycology (4) II (Identical with Micr. 550)

552. Medical-Veterinary Entomology (4) [Rpt./3] II (Identical with Ento. 552)

556. Comparative Vertebrate Anatomy (4) I Evolution and gross structure of vertebrate organ systems. 2R, 6L. P. 8 units of animal biology. (Identical with Ecol. 556)

558. Comparative Vertebrate Histology (4) I 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)

May be combined with 400-level course.

601. Experimental Surgery (2) II 1989-90 Exercises in the surgical procedures commonly necessary in animal experimentation, including aseptic technique, anesthesia, surgical operations, and care of the postsurgical patient. 1R, 3L. P. 3 units of mammalian anatomy.

630. Immunology (4) II 1990-91 (Identical with Micr. 630)

681. Biostatistical Methods in Microbiology (2) 1990-91 (Identical with Micr. 681)

Water Resources Administration (See Hydrology and Water Resources)

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