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GRADUATE CATALOGUE

1959 - 1960
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DIRECTIONS FOR CORRESPONDENCE

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

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Head of Department for further information on departmental course offerings, degree programs, graduate assistantships.

Dean of the Summer Session and Continuing Education for announcements of summer session and extension courses.

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

Director of Placement Service for information on part-time employment, teaching positions.

Director of Residence for information on living accommodations.

Registrar and Director of Admissions concerning transcripts, progress of pending admission applications.

STATEMENT OF MAILING PRIVILEGE

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Entered as second-class matter April 28, 1933, at the post office at Tucson, Arizona, under the Act of August 24, 1912.
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GRADUATE CALENDAR

FIRST SEMESTER

1959-60

Dormitories open at 8:00 A.M. ................................ Sept. 5, Sa.
University faculty meeting .................................................. Sept. 8, Tu.
Registration ................................................................. Sept. 12, Sa., Sept. 14, M.
Classes begin ................................................................. Sept. 15, Tu.
Last day for masters' candidates to file graduate study program for January completion .......... Sept. 15, Tu.
Last day for doctoral candidates to file proposed dissertation subject for May completion ........ Sept. 15, Tu.
Last day to register for credit ............................................. Sept. 22, Tu.
Last day for seniors and R.U. students to petition for graduate credit ........................................ Sept. 25, F.
Last day to register for fall language examination .................................................... Sept. 28, M.
French examination (7:30 P.M.) ........................................ Oct. 5, M.
Spanish examination (7:30 P.M.) ......................................... Oct. 6, Tu.
German examination (7:30 P.M.) ........................................ Oct. 7, W.
Last day for masters' candidates to file proposed thesis subject for January completion ........... Oct. 15, Th.
Last day for masters' candidates to file application for candidacy for January completion .......... Oct. 15, Th.
Last day to drop courses without prior Council approval ........................................... Oct. 24, Sa.
Records close for midsemester scholarship report ...................................................... Oct. 27, Tu.
Veterans' Day—no classroom exercises ........................................ Nov. 11, W.
Last day for masters' candidates to file graduate study program for May completion ............. Nov. 16, M.
Last day for doctoral candidates to file graduate study program for May completion (1961 and 1962) ........ Nov. 16, M.
Homecoming—no classroom exercises ........................................ Nov. 21, Sa.
Thanksgiving recess ....................................................... Nov. 25, W. 10:00 P.M. to Nov. 30, M. 7:40 A.M.
Christmas recess ............................................................ Dec. 19, Sa. 12:00 noon to Jan. 4, M. 7:40 A.M.
Classroom and laboratory sessions end ........................................ Jan. 16, Sa. 12:00 noon
Semester examinations begin .............................................. Jan. 18, M.
Semester examinations end .................................................. Jan. 26, Tu.

1960-61

Sept. 3, Sa.
Sept. 6, Tu.
Sept. 10, Sa.
Sept. 12, M.
Sept. 13, Tu.
Sept. 15, Th.
Sept. 15, Th.
Sept. 20, Tu.
Sept. 23, F.
Sept. 26, M.
Oct. 3, M.
Oct. 4, Tu.
Oct. 5, W.
Oct. 15, Sa.
Oct. 15, Sa.
Oct. 22, Sa.
Oct. 25, Tu.
Nov. 11, F.
Nov. 15, Tu.
Nov. 15, Tu.
Nov. 19, Sa.
Nov. 23, W.
Nov. 28, M.
Nov. 28, M.
Dec. 17, Sa.
Dec. 17, Sa.
Jan. 3, Tu.
Jan. 4, M.
Jan. 16, M.
Jan. 24, Tu.
GRADUATE CALENDAR

SECOND SEMESTER 1959-60

Registration.............................................Jan. 29, F.
Jan. 30, Sa.

Classes begin...........................................Feb. 1, M.

Last day to register for winter language examination............Feb. 1, M.

Last day to register for credit................................Feb. 8, M.

Last day for seniors and R.U. students to petition for graduate credit..............Feb. 11, Th.

French examination (7:30 P.M.)........................................Feb. 8, M.

Spanish examination (7:30 P.M.)........................................Feb. 9, Tu.

German examination (7:30 P.M.)........................................Feb. 10, W.

Last day for masters' candidates to file proposed thesis subject for May completion...........Feb. 15, M.

Last day for masters' candidates to file application for candidacy for May completion........Feb. 15, M.

Last day for doctoral candidates to complete preliminary examinations for May completion........Feb. 15, M.

Last day for doctoral candidates to file application for candidacy for May completion........Feb. 15, M.

Washington's Birthday—no classroom exercises.............Feb. 22, M.

Last day to drop courses without prior Council approval........Mar. 12, Sa.

Records close for midsemester scholarship report..................Mar. 15, Tu.

Easter recess..................................................Apr. 14, Th.
10:00 P.M. to Apr. 25, M.
7:40 A.M.

Last day for final oral examinations for all May completions...............May 20, F.

Records close for all students completing degree requirements........May 24, Tu.

Classroom and laboratory sessions end..........................May 24, Tu.

Semester examinations begin......................................May 26, Th.

Memorial Day—no classroom exercises..............................May 30, M.

Commencement...................................................June 1, W.

Semester examinations end........................................June 4, Sa.

SUMMER SESSION 1959-60

Registration for first summer term..........................June 13, M.

Last day for masters' candidates to file graduate study program for summer completion........June 15, W.

Last day for masters' candidates to file proposed thesis subject for summer completion........June 15, W.

Last day for masters' candidates to file application for candidacy for summer completion........June 15, W.

Last day of first summer term....................................July 16, Sa.

Registration for second summer term.............................July 18, M.

Last day to register for summer language examinations...........July 11, M.

French examination............................................July 18, M.

Spanish examination............................................July 19, Tu.

German examination.............................................July 20, W.

Last day of second summer term..................................Aug. 20, W.

SUMMER SESSION 1960-61

Registration for first summer term..........................June 12, M.

Last day for masters' candidates to file graduate study program for summer completion........June 15, Th.

Last day for masters' candidates to file proposed thesis subject for summer completion........June 15, Th.

Last day for masters' candidates to file application for candidacy for summer completion........June 15, Th.

Last day of first summer term....................................July 15, Sa.

Registration for second summer term.............................July 17, M.

Last day to register for summer language examinations...........July 10, M.

French examination............................................July 17, M.

Spanish examination............................................July 18, Tu.

German examination.............................................July 19, W.

Last day of second summer term..................................Aug. 19, Sa.
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Quentin R. Thomson, M.S.  Assistant Professor of Mechanical Engineering
Martin L. Thornburg, M.E.  Professor of Mechanical Engineering
Inez E. Thrift, Ph.D.  Professor of English
Frank E. Todd, B.S.  Professor of Entomology
Florence W. Toland, M.S.  Assistant Professor of Secretarial Studies and Business Education
Jay E. Treat, Ph.D.  Associate Professor of Physics
Deonisie Trifan, Ph.D.  Associate Professor of Mathematics
Henry Tucker, Ph.D.  Professor of Statistics and Mathematics
Thomas C. Tucker, Ph.D.  Professor of Agricultural Chemistry and Soils
William J. Tucker, Ph.D.  Professor of English
Fred Turner, Jr., Ph.D.  Assistant Professor of Agricultural Chemistry and Soils
Raymond M. Turner, Ph.D.  Assistant Professor of Botany
William J. Van Arsdell  Associate Professor of Animal Science
Mitchell G. Vavich, Ph.D.  Professor of Biochemistry and Nutrition
Mark Voris, B.F.A.  Associate Professor of Art
Robert F. Wagle, Ph.D.  Assistant Professor of Range Management
Archibald F. Wagner, B.A.  Lecturer in Accounting
Robert L. Walker, Ph.D.  Professor of Electrical Engineering
Walter W. Walker  Lecturer in Metallurgy
Charles F. Waltraff, Ph.D.  Professor of Philosophy and Psychology
Albert B. Weaver, Ph.D.  Professor of Physics
Lynn E. Weaver, Ph.D.  Professor of Nuclear Engineering
Donald L. Webb, Ph.D.  Associate Professor of Mathematics
Floyd G. Werner, Ph.D.  Associate Professor of Entomology
Kenneth F. Wertman, Ph.D.  Professor of Bacteriology
Wilson F. Wetzler, Ph.D.  Assistant Professor of Education
Donald H. White, Ph.D.  Professor of Chemical Engineering
Frank Wiersma, M.S.  Assistant Agricultural Engineer
Roy E. Wild, Ph.D.  Assistant Professor of Mathematics
Ned Wilde, M.S.E.E.  Associate Professor of Nuclear Engineering
John R. Williams, Ph.D.  Associate Professor of Agricultural Education
Charles A. Wilmot, Ph.D.  Assistant Professor of Agricultural Economics
Andrew W. Wilson, D.S.S.  Associate Professor of Business Administration
David G. Wilson, M.S.  Assistant Professor of Range Management
Edward N. Wise, Ph.D.  Associate Professor of Chemistry
James M. Witt, Ph.D.  Assistant Professor of Entomology
Merle H. Wittmeyer, M.S.  Professor of Nuclear Engineering
David J. Woloshin, M.A..................................Instructor in German
Elwin G. Wood, Ph.D..................................Professor of Marketing
Mary A. Wood, M.S..................................Associate Professor of Home Economics
Richard B. Woodbury, Ph.D..........................Associate Professor of Anthropology
Neal Wright, Ph.D..................................Associate Professor of Agronomy
Ralph W. G. Wyckoff, Ph.D..........................Professor of Bacteriology and Physics
A. Wayne Wymore, Ph.D..........................Professor of Numerical Analysis
Irving Yall, Ph.D..................................Assistant Professor of Bacteriology
Anthony Ralph Yappel, M.S..........................Associate Professor of Mechanical Engineering
I. Roger Yoshino, Ph.D..................................Assistant Professor of Sociology
Joseph A. Zapotocky, Ph.D..........................Professor of Pharmacy and Pharmaceutical Chemistry
The pursuit of truth and the extension of the boundaries of knowledge, in addition to undergraduate teaching, are recognized as well-established and distinctly important functions of most American universities. The Graduate College is the chief organized agency in the University of Arizona through which its energy and efforts are mobilized to achieve these purposes. Graduates receiving higher degrees should have a well-balanced general education upon which to construct a comprehensive and thorough understanding of a limited field of knowledge. The work of the Graduate College ought by its nature and methodology to stimulate and encourage the refinement and development in the student of the spirit of independent investigation in his chosen field of specialization.

Administration of graduate studies, which have been in progress continuously since the academic year 1898-99, was organized independently in 1934 with the founding of the Graduate College, under the direction of a dean, assisted by a Committee on Graduate Study representative of the various fields in which advanced studies were conducted. Administration of the affairs of the Graduate College is now the responsibility of the dean and the Graduate Council, whose membership is broadly representative of the subject-matter areas in which graduate programs are pursued. The Graduate Council, in turn, has available the assistance and advice of the Committee on Graduate Study, whose primary responsibility is the maintenance of proper standards and the orderly development of graduate programs.

The nature of graduate work. — Students entering the Graduate College should realize that their status is different from that of the undergraduate. Although administrative machinery cannot be wholly dispensed with, the primary aim of the graduate student should not be merely to meet requirements. Students should see in their graduate experience the opportunity to enlarge their knowledge and make themselves independent workers. To realize these ends, personal interest should carry beyond the bounds of requirements. A mere accumulation of units or grades is not sufficient. Achievement should be limited only by the time, energy, and ability at the student's command.
The University of Arizona is well equipped in both faculty and physical resources to undertake graduate programs leading to advanced degrees in 63 departments and fields. Excellent teaching and research facilities are to be found in departments offering advanced degree programs. In addition, certain facilities and services of exceptional importance are available to advanced students. Certain research and service agencies of the state of Arizona have been affiliated with and have been a part of the University of Arizona since their inception. Many of the facilities are interdepartmental in nature or are of interest and importance to graduate students in a number of fields.

The University library. — The University library contains more than 300,000 volumes in addition to 240,000 government documents, 15,000 maps and 20,000 titles on microfilm or microcards. Somewhat more than 12,000 volumes are added annually.

More than 4,500 periodicals and other serial publications are regularly received. Somewhat more than 1,100 journal sets are complete, and continuing efforts are made to secure, as they become available, missing volumes in other sets.

The library regularly receives the publications of the United States government and of the Carnegie Institution, secures publications of state governmental agencies of Arizona and other states, and receives by exchange the publications of many universities and societies.

The Bibliographical Center for Research, in which the University library holds membership, provides interlibrary loans and other valuable services.

A number of special collections relate specifically to Arizona, to the Southwest, and to the fine arts.

The greater portion of the collections in chemistry, physics, and pharmacy is maintained in a reference and reading room in the Chemistry-Physics-Pharmacy building.

While books are freely available to all students, graduate students may obtain stack permits, which allow them direct access to the collections as their work requires. For concentrated periods of library search, graduate students may have stack cubicles assigned for their use.

Arizona State Museum. — The Arizona State Museum was founded as a territorial museum in 1893 and has been associated from the beginning with the University of Arizona as an educational factor in that institution and in the state. Its chief aim is to present the life history of Arizona and the Southwest. Museum collections number more than 100,000 specimens including the renowned materials gathered by the Gila Pueblo Archaeological Foundation. The Museum and Department of Anthropology occupy the same building and are under the same administrative head. This close association enables qualified students to use the Museum collections in pursuit of research problems. The Museum also conducts field work from time to time, and advanced students frequently participate in this activity. The Museum building, open daily to the public, is located at the main entrance to the University campus.

Arizona Bureau of Mines. — The Bureau of Mines is maintained by the state for the express purpose of pursuing research and scientific investigation in the fields of mining, geology, and metallurgy. The Bureau works closely with the teaching departments of the College of Mines, and its completely equipped mineralogical laboratory and pilot plant for mineral dressing are at the disposal of graduate students, who may pursue research programs under the direction of Bureau personnel. The Bureau carries out studies in both extractive and physical metallurgy and cooperates in student research programs in these fields.

University Art Collections. — The University of Arizona is exceptionally fortunate in its art collections. Housed in a completely modern gallery are the masterpieces of the Samuel H. Kress Collection, the modern works of art of the Edward Joseph Gallagher III Memorial Collection, the modern American art of the Leonard Pfeiffer Collection and numerous others. The Kress Collection is one of the finest university collections of Renaissance and later art in the United States.
All works are available for student study, as are the works of temporary exhibitions frequently scheduled at the University Gallery. There is considerable artistic activity in the Tucson community which, together with the Tucson Art Center and several excellent commercial galleries, lends support to the University program. Library facilities in art are excellent, and the T. E. Hanley Collection of some 34,000 volumes is continually growing.

**Steward Observatory.** — The Steward Observatory was made possible in 1916 by the generous gift of Lavinia Steward in memory of her husband, Henry B. Steward. Its principal telescope is a 36-inch reflector, completed in 1922 with the first large telescope-glass ever cast in this country. This is a versatile instrument, with three focal arrangements, Newtonian, Cassegrainian, and coudé, respectively of 15, 45, and 110 feet focal length. The telescope is equipped for direct photography, for photoelectric photometry, and for low-dispersion spectroscopy of very faint objects. Principal areas of research have been: planetary surfaces, white dwarf stars, variable and eclipsing stars, star clusters, and the galaxies. More than 21,000 photographs have been made with this telescope. Guest astronomers from other universities usually work with it for several weeks of each year. This reflector is now (1959) being removed from its original location on the campus to its own site at the Kitt Peak telescope station of the United States National Astronomical Observatory, at an altitude of 6850 feet in the Quinlan Mountains, some 50 miles southwest of Tucson.

The original campus building of the Steward Observatory, now adjacent to the headquarters grounds (offices, laboratories, etc.) of the National Observatory, is currently in process of considerable enlargement for increased provisions for classrooms and laboratories. At the campus station of the Steward Observatory are the Bailey seven-inch Zeiss photographic refractor, three instruction telescopes, and all apparatus for the measurement and reduction of astronomical photographs.

**Numerical Analysis Laboratory.** — The Numerical Analysis Laboratory offers a wide range of mathematical, statistical, computational, and data-reduction services to research activities of the University community. The Laboratory maintains for this purpose (as well as for teaching and research) a well-equipped IBM Type 650 computer, a GE 306 analog computer, and a complete battery of card-handling equipment, as well as a competent and well-trained staff. The Laboratory also administers for research service an IBM 305A RAMAC, a gift of the IBM Corporation to the electrical engineering department. The RAMAC's memory of 35,000,000 items represents the largest computer memory built today.

The Data Reduction Center on campus offers to all University research programs, through the Numerical Analysis Laboratory, the possibilities of data reduction, curve-plotting, and manual calculating by an expert staff operating Benson-Lehner equipment and desk calculators.

All these services are available without charge to faculty and students working on unsupported research projects, for a nominal fee to those working on sponsored research, and to groups outside the University.

The Numerical Analysis Laboratory is also engaged in teaching and research in the fields of programming digital computers, numerical analysis, operations research, and business data processing.

**Applied Research Laboratory.** — The Applied Research Laboratory engages in a very extensive program of research and development with particular, but not exclusive, emphasis in the field of electrical engineering and electronics. Qualified graduate students may receive support as research assistants and may pursue research programs leading to advanced degrees under the guidance and direction of ARL personnel.

**Engineer Experiment Station.** — Administratively a part of the College of Engineering, the Experiment Station pursues a research program in a variety of areas of engineering and, through research assistantships, provides support and research opportunity for a number of qualified graduate students in this field.

**Triga nuclear reactor.** — The Triga reactor was developed by the General Atomic Division of the General Dynamics Corporation as both a training and a research facility.
This swimming 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.

Despite its nominal rating of 10 kilowatts, the reactor operates routinely at an average power level of 100 kilowatts and produces a thermal neutron flux density of $10^{12}$ neutrons per square centimeter per second. It can be operated in fractional second pulses to a level of 200 megawatts or a neutron flux density of $10^{13}$.

The equipment is freely available for research work to all departments of the University interested in irradiation facilities. Objects of a few cubic feet in size may be encased and lowered to the reactor core for exposure to neutron and gamma radiation. Smaller samples may be placed directly in one of the 40 exposure positions provided. Samples that must be analyzed promptly can be removed almost instantly by a pneumatic "rabbit tube." Up to 80 curies of radioisotopes with moderate and short half-lives can be produced; useful quantities of radioisotopes of 62 of the first 83 elements can be prepared.

**Electron optics facility.** — The University is currently developing an electron optics laboratory in order to pursue research in this field and to make available to all interested departments the powerful research tools which the techniques of electron optics provide.

Presently in operation are two Philips electron microscopes, one of medium and one of high resolution. An experienced, highly competent electron microscopist offers formal instruction in microscopy, and is available to assist and advise faculty and qualified graduate students in the use of the instruments and in their application to a wide variety of research problems. The equipment and facilities of the laboratory are freely available to the faculty and graduate students of all departments.

**Agricultural Experiment Station.** — One of the four divisions of the College of Agriculture, the Experiment Station pursues a research program in agriculture and home economics. In addition to the experimental farms at a variety of locations within the state, the Station maintains research laboratories at Tucson, in the Salt River Valley, and at Yuma. Constant research and experimentation involving field crops, vegetables, citrus, cotton, beef, sheep, swine and poultry, breeding, production, improvement, and diseases offer almost endless opportunities for the graduate student in agriculture to undertake study and research in the laboratory and in the field under the expert guidance of Experiment Station personnel.

**Institute of Water Utilization.** — Organized within the Agricultural Experiment Station, the Institute conducts research to develop more efficient utilization of natural rainfall and available surface and ground-water supplies through studies in basic and applied hydrology, irrigation, heat-budget relationships, treatment of watersheds to increase yields, purification of saline waters, evaporation suppression, and artificial recharge of ground-water basins. The Institute supports graduate research assistantships and cooperates in the research programs of students in related departments.

**Institute of Atmospheric Physics.** — The Institute of Atmospheric Physics of the University of Arizona is a research organization whose primary objective is that of developing fundamental knowledge of the weather and climate of Arizona, of the Southwest, and of arid regions in general.

In its research program, the Institute places particular emphasis upon the study of those atmospheric processes which are associated with the formation of clouds and rain. Precipitation excesses or deficits determine, more than any other natural factor, the level at which the economy of an arid region may function.

In general, it may be said that the Institute is attacking the problem of water as the most fundamental factor in an arid land all the way from the standpoint of the regional relationships of the flux of water vapor down to and including the microphysical properties of the liquid and solid water particles in the cloud.

Such an attack involves the use of high-speed punch-card computing facilities, radar equipment, elaborate photographic techniques, air-tagging and tracing experiments, instrumented airplane flights into the clouds, and a variety of other specialized laboratory and field experiments. The Institute is well equipped with both specialized research equipment and general meteorological instruments for this work.
The Institute also has an extensive program in solar energy utilization. All of this work is done at its new Solar Energy Research Center, which is a 1600-square-foot building fully heated by solar energy and cooled by reversing the system at night to cool water by radiation to the night sky.

**Geochronology Laboratories.** — Unique among research groups, the Geochronology Laboratories are organized and equipped to bring to bear on any appropriate research problem essentially all scientific methods and techniques applicable to the dating of terrestrial events. Scientists from many disciplines cooperate in studies in archaeological stratigraphy, dendrochronology, geochemistry, geological stratigraphy, geomorphology, paleoclimatology, paleontology, palynology, and sedimentation.

The geochemical laboratory is equipped to carry out radiocarbon dating studies, potassium-argon and rubidium-strontium dating, and helium studies. The air-liquefaction facilities of this group can supply liquid air and liquid nitrogen to any department or individual whose program requires these coolants.

Investigators in a variety of fields find the facilities and personnel of the Laboratories available for a cooperative approach to dating problems.

**Laboratory of Tree-Ring Research.** — The Tree-Ring Laboratory is engaged in research regarding tree growth and climate, the development of tree-ring chronologies, and the application of tree-ring dating methods to prehistoric events, particularly in archaeology. The development of the science of dendrochronology at the University of Arizona has led to the present collection of some 60,000 prehistoric tree-ring specimens in addition to another 15,000 specimens from living or recently dead trees all of which are available for study and use in the dating of archaeological sites and events.

**Bureau of Business and Public Research.** — The Bureau is a research and service agency within the College of Business and Public Administration. Its broad objectives include the collection, analysis, and dissemination of economic data. It is the Bureau’s purpose to promote development of the state’s resources, to assist business and governmental units to deal intelligently with the present and plan for the future, and to assist both faculty and students in the field of business and economic research.

Over the years, the Bureau’s functions have extended to include research in various aspects of public administration, social administration, area development, community organization, and community planning.

The Bureau publishes monthly the *Arizona Business and Economic Review* and special studies and monographs from time to time. It also maintains a reference library on business and economic and related subjects for the use of students, faculty, and the public.

The Bureau supports a research assistantship open to a qualified graduate student. Its personnel and facilities are available to assist other graduate students through individual counselling, guidance in the use of the reference library, and advice regarding field research techniques. Staff members of the Bureau may serve as research and thesis directors for students in appropriate departments. The Bureau may consider publication of the results of student research and, in certain cases, offer assistance in typing and tabulating, reproduction of maps, charts and photographs; and in other appropriate ways.

**Bureau of Ethnic Research.** — A part of the Department of Anthropology, the Bureau is an information and research center devoted to the study of the position and problems of the Indian in the Southwest today. Its activities include research in applied anthropology, graduate student training, an educational program of popular publications on aspects of Indian affairs and the collection and maintenance of reference materials for research on modern Indian life.

The research program in applied anthropology comprises a series of problem-centered studies supported by various federal and private agencies. Though specific problems may involve concentration on Indian administration, health, or economics, a basic and continuing aim is the collection of comparative demographic and social data of a quantitative nature for the major tribal groups in Arizona.
Research opportunities and financial support for graduate students are provided through employment in the applied anthropology program when grant and contract funds are available. In addition, a graduate assistantship is provided by the university annually for a graduate student enrolled in the Department of Anthropology. The graduate assistant will be expected to pursue study and research which parallels the applied anthropology program.

Arizona Cooperative Wildlife Research Unit. — The Arizona Cooperative Wildlife Research Unit is sponsored and supported jointly by the University of Arizona, the Arizona Game and Fish Department, the U. S. Fish and Wildlife Service, and the Wildlife Management Institute. The facilities and personnel of the Unit are available to graduate students who wish to pursue both class work and research programs leading to advanced degrees in fisheries management and wildlife management.

Arizona affords unusual opportunities for research on game management problems because of the large variety of game species native to the state and the wide diversity of habitat. The great number of impoundments of Arizona's waters present many unsolved problems that offer opportunities for research in fresh-water fisheries.

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.

Museum of Northern Arizona. — 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 can be arranged by the procedure commonly used for work done in absentia for credit in 400 Research to apply toward requirements for an advanced degree, for 410 Thesis, and for 420 Dissertation.

The Museum offers summer research assistantships in anthropology, art, biological sciences, and geology for which qualified graduate students at the University of Arizona may apply. Subject to prior approval by the student's major adviser, the Director of the Museum, and the Dean of the Graduate College, a summer assistant may receive graduate credit for research accomplished while holding an assistantship.

Southwestern Research Station. — 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 southwestern Arizona. The Station proper is located at an elevation of 5400 feet in a moderate evergreen-woodland climate, midway between the desert below and the coniferous forest above. A wide variety of life zones are represented within a few miles of the Station between the desert floor and the fir-covered peaks at 9000 feet. This unspoiled area within the Coronado National Forest includes many protected wilderness areas accessible only on foot or horseback.

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

Station living facilities and equipment are excellent, and the Osborn Laboratory is well equipped for many kinds of modern field and laboratory research in ecology and physiology. The Station is an excellent field base for almost any kind of field work in biology, geology, paleontology, resource management, and wildlife management.
Arizona-Sonora Desert Museum. — The Arizona-Sonora Desert Museum is a self-supporting, non-profit institution situated 14 miles west of the city of Tucson in a saguaro and palo verde landscape of the Sonoran desert. This living indoor and outdoor museum of natural history enables one to gain in a few hours a knowledge of the flora and fauna of the Southwest that would otherwise require many years. Unique habitat groups and other displays of living animals and plants have been developed at this unusual museum.

The Museum cooperates with educational institutions at all levels as an outdoor education center and provides laboratory and field space for research in the natural history of Arizona and Sonora, Mexico, with special emphasis on the Sonoran desert common to both states.

Arizona Pioneers' Historical Society. — For students who plan to do historical research on southwestern topics, the large collections of the Arizona Pioneers' Historical Society are housed conveniently in a new building less than one block from the campus. 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 research library. The research library is one of the most complete in the Southwest. In addition to a basic and broad collection of some 25,000 southwestern books and pamphlets, its holdings include 22,000 photographs and pictures, some 1300 maps, and more than 1700 bound volumes of Arizona newspapers beginning with the first issue of the first weekly in 1859. Most important, perhaps, are the 5000 and more individual collections of manuscript material which the Society has accumulated over seventy-five years. Here the researcher will find unpublished letters, diaries, journals, and business records of wide diversity and importance. Several of the larger collections contain many thousands of pieces of unpublished material. A number of books, articles, and historical papers have been written by scholars who discovered invaluable sources in the manuscript collections of the Society.

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 the campus of the University. These research organizations work closely with the University, and a number of their personnel also hold University staff appointments.

ACCREDITATION

The University of Arizona was accredited by the North Central Association of Colleges and Secondary Schools in 1917 and by the Association of American Universities in 1924. The University or its appropriate colleges or departments have membership in or are accredited by the following: the American Association of Collegiate Schools of Business, the American Bar Association, the Association of American Law Schools, the American Chemical Society, the American Council on Pharmaceutical Education, the Engineers' Council for Professional Development, the National Association of Schools of Music, the National Association of State Universities, and the American Association of Land Grant Colleges and State Universities.

FEES

* Nonresident tuition fee (12 or more units), per semester........................................ $250.00
* Nonresident tuition fee (6 to 11 units) per unit..................................................... 21.00
† Registration fee, per semester (6 or more units).................................................. 90.00
Registration fee, per semester (fewer than 6 units), per unit.................................. 11.00
Graduation fee ........................................................................................................... 5.00
Binding fee ................................................................................................................ 5.00
Dissertation fee (microfilm of dissertation)............................................................... 25.00

* Graduate assistants and certain designated fellows are exempt from non-resident tuition and from laboratory, music, and field trip fees, but not from the registration fee.
† Includes charges for student activities, student union, infirmary, artist series, library, and alumni association.
Late registration ..................................................... 5.00
Change of schedule ............................................. 1.00
Music major fee (if applicable), per semester .......... 40.00
Oral examination, if candidate not registered ........ 5.00
Unexcused absence from Commencement (second semester graduates) .................. 10.00
Transcript fee (extra copy) .................................... 1.00

HOUSING

Graduate students assume responsibility for their own living arrangements and will be assisted in finding accommodations by the Residence Department. Available only to married veterans who are enrolled for 10 or more units of regular University work are a limited number of quonset hut and temporary dwelling units rented furnished or unfurnished at $28 to $35 a month. Demand is such that students are rarely able to obtain these accommodations from the beginning of their residence. Rooms in the dormitories are available if there are vacancies after applications from undergraduates have been processed. When graduate students are given accommodations in the dormitory system, they conform to all regulations for senior students. Dormitory space for unmarried graduate students is available for summer sessions.

A Head Resident is in charge of each dormitory. The Head Residents have student assistants who receive a room in exchange for their services. Graduate students interested in appointments as student assistants to Head Residents may obtain additional information by writing to the Dean of Men or to the Dean of Women.

UNIVERSITY CAFETERIA

The University operates fountains and dining halls in the Student Union Memorial Building under the management of a trained dietitian. Service is cafeteria-style. The cost of food for the average student is approximately $50 to $55 a month.
Admission. — Admission to the Graduate College is open to persons who hold the bachelor's degree from the University of Arizona or from a college or university approved by the University of Arizona. Admission in any case is granted only after approval of the candidate's previous academic record by the registrar, the dean of the Graduate College, and the heads of the two departments in which the candidate proposes to do the greater portion of his work. 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; and prospective graduate students are urged to determine from the dean their status in this regard. Students whose preparation is such that they are unable temporarily to elect any work for graduate credit must register in the appropriate undergraduate college.

Admission of foreign students. — The University of Arizona requires that all foreign students, as a condition of admission to the University, purchase accident and sickness insurance through the Insurance Division of the Institute of International Education or other accredited agency. The cost of a policy effective for six months following entry into the United States is $13.50 and the cost of a one-year policy is $25.20. The insurance application forms are issued by the office of the University Registrar and Director of Admissions.

Application for admission. — Application for admission to the Graduate College must be made on the blanks furnished by the dean of the Graduate College. An applicant from another institution should request that a complete transcript of all undergraduate and graduate work done and degrees received be sent directly by the institution concerned to the Registrar and Director of Admissions of the University of Arizona. Both the application and the transcript must be on file prior to registration.

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

Applicants who expect to pursue doctoral programs in psychology or education should submit scores on the aptitude test; for master's and doctoral work in geology or zoology, the advanced test score is required. Students who are admitted to these departments without having taken the Graduate Record Examination must do so prior to advancement to candidacy for their degrees. It is suggested but not required that in addition to providing a transcript of record of undergraduate and graduate work, each applicant for admission to the Graduate College take the Graduate Record Examination and submit a transcript of his scores. Applications for the examination which will be administered locally as well as in other centers, should be sent, together with an examining fee of $8 to $14, to Educational Testing Service, P. O. Box 27896, Los Angeles 27, California, or 20 Nassau Street, Princeton, New Jersey.
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 count upon taking the final examination for a degree at any set time. Students seeking the master's degree usually apply for admission to candidacy after the first semester of residence.

Graduate credit for seniors and unclassified students. — A 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, or within ten days thereafter, for the action of the Graduate Council. This petition must be endorsed by the professor in charge of the course and the student's major professor. The Council will not approve a petition unless the senior has a grade average of 2.50 or better on all work already completed in the University, is proceeding toward graduation as directly as possible, and does not propose a total load to exceed 16 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 16 and the number necessary to complete requirements for graduation.

A student who holds the bachelor's degree but who is not registered in the Graduate College may petition for permission to take courses for graduate credit. His petition must be filed within ten days following registration, must be recommended by the instructor of the course and the head of the department concerned, and must be approved by the Graduate Council.

General prerequisites for major and minor graduate credit. — The undergraduate major, or its equivalent, in any field of study is prerequisite to major graduate work in that field. In some cases a field of concentration in the undergraduate work different from but suitably related to the graduate major may be acceptable. The minimum requirement in education is 15 units, of which 3 may be in general psychology.

Supporting or minor courses have as a prerequisite for graduate credit a minimum of 6 units basic to the subject, including all prerequisites stated in the description of the course.

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

Regular graduate credit courses. — Regular courses numbered 300 and above are intended primarily for graduate students, while courses numbered 200-299 may be taken for graduate credit. (See page 50 for classification of regular courses by number.)

Other courses for graduate credit. — In addition to the regularly scheduled campus offerings, the University also offers a variety of specially scheduled courses at other times and places. Such courses are designated by numbers of four digits and many are available for graduate credit. The first digit (7, 8, or 9) indicates the conditions under which a particular course is offered and the limit of applicability, if any, toward meeting requirements for an advanced degree. The last three digits are the same as the number of the regular campus offering unless there is no such counterpart.

All courses given off the campus as extension courses are designated by four-digit numbers beginning with 7. As many as six units of credit in courses in the 7200 and 7300 series may be applied toward meeting requirements for the master's degree.*

Certain other courses (usually offered on the campus only) are designated by four-digit numbers beginning with 8. As many as 12 units of credit in courses in the 8200 and 8300 series (or six units in addition to six units of those in the 7200 or 7300 series) may be applied toward meeting requirements for the master's degree.*

The limits on credit for courses in the 7200, 7300, 8200, and 8300 series (cited in the two paragraphs immediately above) are subject to the general restriction that such limits are reduced by the number of transfer units offered (see below).*

* Extension work completed prior to September, 1959, will be considered equivalent to courses in the 7000 series if taken at locations away from the campus and equivalent to courses in the 8000 series if taken on the campus.
Certain courses offered only on the campus under conditions duplicating those of regularly scheduled campus offerings are designated by four-digit numbers beginning with 9. There is no restriction on the amount of credit in courses in the 9200 and 9300 series that may be applied toward meeting requirements for an advanced degree.

No course in the 7000 or 8000 series may be applied toward meeting requirements for the Doctor of Philosophy degree.

Transfer of graduate credit. — The University of Arizona accepts credit by transfer from other accredited institutions. Not more than six transferred units may be offered toward the master's degree and this may be further limited by the amount of credit offered in courses in the 7000 and 8000 series. Such transfer of credit may be established to apply toward an advanced degree only upon satisfactory completion of such additional courses as may be prescribed by the head of the corresponding department in the University.

In any case, transfer of credit will not be made unless the grade earned was 1 or 2 (A or B) and until the student has completed satisfactorily one semester of graduate work at the University of Arizona.

Credit previously obtained for extension work offered by other institutions will not be transferred.

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

Scholarship requirements. — A high level of performance is expected of students enrolled for graduate credit. A student who does not appear to be making satisfactory progress in his graduate work may be required to withdraw from the University. No student will be recommended for the award of an advanced degree unless he has achieved a grade average of 2.0000 or higher on all course work taken for graduate credit with certain exceptions as follows: The grade average will be computed on all 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 dropped with a passing grade and those numbered 299, 399, 400, 405, 410, and 420. The grades of "4" and "5" do not carry graduate credit but are included in the general average. After the first six weeks of classes, courses may not be dropped by graduate students except for cause approved by the Graduate Council.

Maximum study load. — The usual maximum load for students registered in the Graduate College is 16 units. Students are asked not to request permission to take more than this maximum.

Thesis and dissertation work in absentia. — Under conditions approved by the head of the major department and the dean, a portion of a student's thesis or dissertation work may be done in absentia. If not registered at the time the thesis or dissertation is submitted and the final oral examination is held, a candidate who has been doing such work in absentia must pay a special examination fee of $5.

Auditing of courses by graduate students. — With the consent of the dean and the instructors concerned, students enrolled in the Graduate College during the academic year may 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.

GRADUATE STUDY IN SUMMER SESSION

The University of Arizona summer session gives particular attention to graduate study. All courses numbered 300 and above are definitely organized as graduate courses and carry graduate credit. Courses numbered 200 to 299 inclusive are upper-division courses which are acceptable for graduate credit.

In response to the increasing demand for graduate work during the summer, several departments of the University have provided for individual research in their special fields. Such courses are listed under the respective departments. Students who wish to pursue any of these courses must obtain the consent of the respective instructors before registering for the courses.
In certain departments provision is made for teachers in service and other 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.

Tuition. — The tuition required of all students registered for credit is $10 per unit (semester hour). There is no additional nonresident fee for out-of-state students.
Tuition and fees. — Graduate assistants and certain designated fellows are exempt from the nonresident tuition fees and from laboratory, music, and field-trip deposits and fees.

Graduate assistantships. — Both teaching and research assistantships are available as described below. Graduate assistants are required to register for at least six units of graduate work as a condition of their appointment. Except by special permission of the dean, the student may hold a graduate assistantship only in the department of his major subject, except for the student in education who may hold an assistantship in either education or his teaching field.

Graduate teaching assistantships. — Approximately 200 appointments in this category are available annually—many of them being open to first-year graduate students. Salaries vary, but first-year graduate students carrying a full course load may expect to receive approximately $1200 for the academic year for service not exceeding 12 hours a week. Larger salaries with additional work on a reduced schedule are offered by most departments. The following departments offer one or more teaching assistantships:

- Accounting
- Agronomy
- Animal Science
- Anthropology
- Art
- Astronomy
- Bacteriology
- Botany
- Business Administration
- Chemistry
- Civil Engineering
- Drama
- Economics
- Education
- Electrical Engineering
- English
- Entomology
- Geochronology
- Geology
- Government
- History
- Home Economics
- Mathematics
- Mechanical Engineering
- Metallurgy
- Music
- Pharmacy
- Physical Education (Men)
- Physics
- Plant Pathology
- Psychology
- Romance Languages
- Secretarial Studies
- Sociology
- Speech
- Watershed Management
- Zoology

Graduate research assistantships. — Approximately fifty appointments are available in a number of departments. Salaries are comparable to those for teaching appointments and range from $1200 (for academic year appointments allowing full course load and requiring 12 hours of service per week) to $2400 (for calendar year appointments requiring more service time). In most cases, research performed may be counted as part of the thesis or dissertation requirement for an advanced degree. The following departments offer one or more research assistantships:

- Agricultural Biochemistry
- Agricultural Chemistry and Soils
- Agricultural Economics
- Animal Science
- Arizona and the West (Historical Quarterly)
- Arizona State Museum
- Bureau of Business and Public Research
- Bureau of Ethnic Research
- Cooperative Wildlife Unit
- Dairy Science
- Engineering Experiment Station
- Entomology
- Horticulture
- Institute of Water Utilization
- Mining and Metallurgical Engineering
- Plant Pathology
- Poultry Science
- Steward Observatory
- Tree-Ring Laboratory
- Watershed Management
Some of these departments and a number of others also administer assistantships under research programs sponsored and supported by foundations, government, and industry.

Several departments also administer funds which provide grants-in-aid.

**American Association of University Women Fellowship.** — The Tucson Branch of the American Association of University Women offers a fellowship of $200 to a qualified woman doing graduate work. Application may be made to the Chairman of the Committee on Scholarships and Awards.

**Arizona Bankers' Association Fellowship.** — A fellowship of $500 for the academic year is awarded to a qualified graduate student in either the College of Agriculture or the College of Business and Public Administration whose research problem will be concerned with commercial bank loans to farmers and/or ranchers.

**The Arizona Corral Theatre Fund.** — The Arizona Corral Theatre has established a fund to aid worthy graduate students with a major in drama. Awards will be made upon recommendation of the Department of Drama in varying amounts depending on scholarship, need and the research project.

**Arizona Cotton Growers' Association Fellowship.** — A fellowship of $2000 with an additional $500 for equipment and travel is offered to a graduate student for research in the field of cotton breeding. The applicant will be selected by the Plant Science Graduate Committee and a representative of the Arizona Cotton Growers' Association.

**The Paul Steere Burgess Graduate Fellowship.** — This fellowship of $1,000 was established in honor of Paul Steere Burgess, Dean of the College of Agriculture, and for a time President of the University. It will be awarded upon recommendation of the Dean of the College of Agriculture for graduate study in any department of that college. Application should be received by April 1. Fellows are exempt from nonresident tuition.

**Bert S. Butler Scholarships.** — Dr. B. S. Butler, widely known for his contributions to economic geology, professor of geology and for many years head of the Department of Geology in the College of Mines, at the University of Arizona, together with his wife, has established a fund to support the Bert S. Butler Scholarships. This scholarship in geology is awarded on the basis of character, scholarship, need, and professional potential, and is in the amount of $600 annually to a graduate student in geology. The recipient shall be recommended by the College of Mines Scholarship Committee and approved by the Committee on Scholarships and Awards. Any student receiving an award may be eligible for successive annual scholarships.

**The Comins Fund.** — By the terms of the will of Eben F. Comins, a fund was established to encourage studies which will contribute to the cultural understanding of the American Indian. The Department of Anthropology makes awards from this fund for research in art and anthropology.

**General Electric Computer Department Honor Program in Electrical Engineering.** — The General Electric Computer Department Honor Program has established a graduate grant of $2500 for a candidate for the Doctor of Philosophy degree in the Department of Electrical Engineering. The student is to be selected by the head of that department and the dean of the Graduate College. It is required that the student's dissertation be in the field of information processing and that the student agrees to work, during the summer, for the General Electric Company at regular salary rates. Research equipment and tuition are included in the grant.

**Irrigation-Engineering Fellowship.** — Dr. G. E. P. Smith has established a fellowship which will amount to $600 a year. Applicants must be graduate students who have a knowledge of irrigation principles and practices. The selection will be made upon the recommendation of the head of the Department of Agricultural Engineering. It is required that approximately a third of the student's academic program be devoted to study and a report on a research problem of interest and importance to the state of Arizona.
The Carlos C. Jacome Memorial Scholarship. — The income from a gift of $5000 made by members of the family of the late Carlos C. Jacome is available to a junior, senior, or graduate student in the College of Business and Public Administration, selected by a committee consisting of the head of the work in merchandising, the dean of the college, and a merchant selected by the president of the Tucson Merchants' Association. The student shall engage in some research in the field of problems of the independent business. Under exceptional conditions, the scholarship may be held by the same student for two successive years.

Kiwanis Club of Sunshine Scholarship. — The Kiwanis Club of Sunshine, in Tucson, Arizona, makes available annually a sum of money for worthy qualified senior or graduate student(s) selected by the University Committee on Scholarships and Awards.

Shell Chemical Corporation Fellowship. — The Shell Chemical Corporation Fellowship has been founded in the College of Mines of the University of Arizona to support graduate research leading to the evaluation of chemical compounds used as flotation reagents in the minerals industry. The stipend of the fellowship is $2500, and an additional allotment is established to bear the expense of chemical analyses and similar incidentals. The work will lead to a graduate degree in metallurgical engineering. Selection of the fellow will be made by a committee of the faculty of the College of Mines.

Steward Observatory Fellowship. — A fellowship of $1200 for the academic year is granted to a graduate student doing research in astronomy. Fellows are exempt from nonresident tuition.

Phelps Dodge Graduate Scholarships. — The Phelps Dodge Foundation offers two scholarships for graduate students in the amount of $1200 each, plus tuition and fees. One of the graduate awards will be made to a male student chosen from the engineering student body of the University of Arizona for advanced study in mining, metallurgy, or other fields allied or pertaining to the mineral industry. One graduate student will be chosen from the student body of the University of Arizona for advanced study in any field that the student may select and for which he or she may be qualified. Recipients of graduate scholarships may pursue their advanced studies at an institution other than the University of Arizona, provided that the choice of institution is approved by the Committee on Scholarships and Awards.

The Maxwell N. Short Memorial Scholarship. — As a memorial to Maxwell N. Short, professor of petrography and head of the Department of Geology at the University of Arizona, members of his family offer annually an award of approximately $300 to a senior or graduate student to assist in defraying the expenses of a thesis or research problem in the geology of the Southwest or Mexico. The award will be made upon the recommendation of the faculty of the Department of Geology.

The U. S. Bureau of Mines Fellowship. — The U. S. Bureau of Mines, Tucson Station, in cooperation with the College of Mines, has established a graduate fellowship of approximately $1500 to be awarded to a student who is working toward the master's degree in Metallurgical Engineering. In addition to research work conducted in the laboratories of the U. S. Bureau of Mines on the campus during the academic year, the student is also required to conduct research during July and August. Fellows are exempt for nonresident tuition.

University Graduate Scholarships. — A number of scholarships covering the fee for nonresident tuition were established in 1948 by the Board of Regents of the Universities and State College of Arizona. In awarding these scholarships the Graduate Council will give preference to applicants who have superior undergraduate records and who are in need of this financial assistance.
GRADUATE DEGREES

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

**Fine Arts.** — Art, art education, history of art, drama, applied music, music composition, music theory, history and literature of music, music education, cello, clarinet, organ, piano, trombone, viola, violin, voice, and speech.

**Humanities.** — English, French, German, Spanish, philosophy.

**Social Sciences and Business.** — Accounting, agricultural economics, agricultural education, anthropology, business administration, economics, education, government, history, home economics, marketing, psychology, public administration, and sociology.

**Biological Sciences.** — Agricultural biochemistry, agronomy, animal science, bacteriology, botany, dairy science, entomology, horticulture, plant breeding, plant pathology, poultry science, range management, watershed management, wildlife management, and zoology.

**Physical Sciences and Engineering.** — Aero-space engineering, agricultural chemistry and soils, agricultural engineering, astronomy, chemical engineering, chemistry, civil engineering, electrical engineering, engineering mechanics, geochronology, geology (including mineralogy and paleontology), mathematics, mechanical engineering, metallurgical engineering, metallurgy (physical), meteorology and climatology, mining engineering, nuclear engineering, pharmacy, and physics.

Major work and research leading to the Doctor of Philosophy degree are offered in the following fields: Aero-space engineering, anthropology, bacteriology, agricultural biochemistry and nutrition, chemistry, civil engineering, education, electrical engineering, engineering mechanics, geology (including mineralogy and paleontology), mathematics, mechanical engineering, metallurgy, meteorology and climatology, pharmacy, physics, plant science (agricultural chemistry and soils, agronomy, botany, entomology, horticulture, plant breeding, plant pathology, range management, wildlife management), psychology, and zoology.

The advanced degrees offered by the University through the departments and divisions approved for graduate work are as follows:

- Master of Accounting (M.Ac.)
- Master of Agricultural Education (M.Ag.Ed.)
- Master of Arts (M.A.)
- Master of Business Administration (M.B.A.)
- Master of Education (M.Ed.)
- Master of Electrical Engineering (M.E.E.)
- Master of Fine Arts (M.F.A.)
- Master of Home Economics Education (M.H.E.Ed.)
- Master of Mechanical Engineering (M.M.E.)
- Master of Music (M.M.)
- Master of Music Education (M.M.Ed.)
- Master of Public Administration (M.P.A.)
- Master of Science (M.S.)
- Doctor of Education (Ed.D.)
- Doctor of Musical Arts (D.M.A.)
- Doctor of Philosophy (Ph.D.)

A number of departments give more than one degree and a great many specializations are available within the degrees listed. Specific details regarding degree programs and specializations are given in the informative text preceding the listing of course offerings for each department.
REQUIREMENTS FOR
MASTERS' DEGREES

MASTER OF ARTS AND MASTER OF SCIENCE

The degrees of Master of Arts and Master of Science will be conferred for advanced work
done by students who have received the bachelor's degree from this institution or from 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. Thirty
units of graduate work, including the thesis, and completion in a period of not more than six
years are required. Not less than 15 units must be in a major field. Two or more closely allied
subjects may be combined to form a major. The equivalent of two semesters of residence, in-
volving completion of not fewer than 24 semester hours of graduate credit are required, ex-
cept as thesis work in absentia may be approved; the remaining six units may be transferred
from another accredited graduate school or earned outside the regularly scheduled campus
offerings in other approved courses offered by the University of Arizona. (See page 29 for
limitations regarding transfer and other work.) On approval of the head of the department
and the Graduate Council, thesis work 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 require-
ments 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. valida-
tion of old work by examination is not permitted.

Major professor and director of thesis. — The head of the department in which the can-
didate's major work lies shall designate as his major professor and general adviser some mem-
er of the department, and as his director of thesis either this same person or some other
member of the department. The major professor shall approve the program of study and the
thesis and, with the approval of the dean, shall select at least two members to serve with him
as an advisory and examining committee.

Program of study. — Each applicant for a master's degree shall submit to the dean for
approval, on a form provided for the purpose, a program of study for the work proposed, duly
approved by the major professor. The program must be submitted not later than six months
prior to the final oral examination.
Advancement to candidacy. — A petition for advancement to candidacy for the degree sought must be filed with the dean not later than the beginning of the last semester of work. Acceptance for candidacy shall be subject to final approval by the Graduate Council. Departments which so desire may require a preliminary comprehensive examination before officially approving any candidacy for the master's degree. In any case, candidacy will not be granted before a program of study and a thesis proposal have been approved.

Thesis. — A thesis in the major field is required. (In the Department of Mathematics, the requirement of a thesis for the master's degree is made optional with the department.) The title and a brief outline of the thesis proposed, approved by the major professor and on a blank provided, shall be filed with the dean not later than the beginning of the semester during which the requirements for the degree are to be completed. Credit for the thesis shall be 2 to 8 units, inclusive of courses intended to aid in the preparation of the thesis. One copy of the completed thesis, accepted and approved by the major department, and an abstract of 200 words or fewer shall be deposited with the dean at least one week before the oral examination. Instructions relating to the form of the thesis may be obtained from the dean. Following the final oral examination two copies of the thesis and the copy of the abstract (including the thesis and abstract previously submitted) are filed with the dean for subsequent deposition in the University Library; and a fee of $5 is paid to the University Comptroller to cover the cost of binding. A third copy of the thesis may be required by the major department at its option.

Final Examination. — A candidate for the master's degree must pass a final examination before a committee chosen by the major department with the approval of the dean. The time and place must be approved by the dean at least one week in advance. The examination shall be in part a defense of the thesis but, in the main, a general examination on subject matter related to the candidate's field of study. It shall be in part oral, or may be wholly so, at the option of the major professor. In case a written examination, in part, is deemed advisable, the departments of the candidate's field of study shall cooperate in preparing one set only of questions which will correlate as fully as possible the supporting subjects with the more important major field of study. At the final oral examination, the Graduate Council shall be represented, and all members of the general faculty have the privilege of being present. Any candidate who fails in the final examination may, upon recommendation of the major professor and approval of the Graduate Council, be granted a second examination after a lapse of at least one semester. The second examination is final.

A certification that the thesis has been accepted and that an oral examination has been satisfactorily passed shall, together with the two duly approved copies of the thesis, be filed with the dean not later than one week before the conferring of the degree.

Special requirements for the Degree of Master of Arts with a Major in Art Education or the History of Art. — The art department offers graduate courses leading to the degree of Master of Arts in the fields of history of art and art education. Students will be admitted to the graduate program who have completed an undergraduate major in art, history of art, or art education from this institution or one of similar standing. The requirements are the same as those outlined above for the degree of Master of Arts or Master of Science with the following exceptions. For specialization in the history of art, the student is required to demonstrate a reading knowledge of French, German, or the foreign language appropriate to his special interest, before applying for candidacy for the degree. For the specialization in art education, an independent project may be offered in lieu of the thesis. Also in this specialization, the student may elect courses in art, education, and the teaching minor. Electives may be chosen to meet certification requirements in Arizona or other states. The project submitted must be accompanied by all sketches, preliminary works, organized annotations of research, and other materials connected with its accomplishment, together with a written essay setting forth the method of procedure and containing, where appropriate, a reproduction or reproductions of the work.

Special requirements for the Degree of Master of Arts with a Major in Drama. — The Department of Drama offers courses leading to the degree of Master of Arts. Students who have received the Bachelor of Fine Arts degree or the Bachelor of Arts degree, with a major in drama, from this institution or from one of similar standing are admitted for the advanced work. Upon evaluation, any deficient units for the above degrees shall be determined by the major professor. Otherwise, the requirements are the same as those outlined above for the
REQUIREMENTS FOR MASTER'S DEGREES

degree of Master of Arts or Master of Science, except that an original work of playwriting, scenic art, or performance may be offered in lieu of a thesis. Such original work, submitted or performed, must be accompanied by schematic diagrams, prompt books, organized annotations of research, and subjective observation, together with a written report setting forth the method of procedure. The University will retain the work submitted. If an original play is offered, it must be produced in such form as is indicated by the department.

Special requirements for the Degree of Master of Science with a Major in Wildlife Management in the Department of Zoology. — Candidates for this degree will be required to spend a minimum of one year on a field problem and one year on course work and the preparation of a thesis. The program of studies shall include at least 15 units of research work for the thesis and at least 15 units of course work.

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

MASTER OF ACCOUNTING

The degree of Master of Accounting is a professional degree designed to provide training for a career in public accounting practice, in private business enterprises, in the government service, or in the teaching of accounting courses in colleges and universities. All general regulations and requirements for the Master of Science degree apply to this degree except as indicated below.

The undergraduate major to be completed before graduate credit may be earned in courses in accounting shall consist of not fewer than 15 units in accounting, plus such number of units in accounting and related courses in business and economics as may be needed to make a total of 30 units.

A minimum of 32 units of graduate course work, of which not fewer than 22 shall be in the field of accounting is required for the degree. A thesis is not required; but with the approval of the department a thesis may be presented in fulfillment of from four to six of the 22-unit required minimum of accounting courses.

For students whose undergraduate work has been in areas other than business and related fields, a minimum of two years of work, or 62 units, will be necessary to meet the requirements for the Master of Accounting degree. For students whose undergraduate work has been in business and related fields, the time necessary to complete these requirements may be less than two years depending upon their field or fields of specialization as undergraduates.

MASTER OF AGRICULTURAL EDUCATION AND MASTER OF HOME ECONOMICS EDUCATION

The general regulations and requirements for the Master of Arts and Master of Science degrees apply to these degrees with the following exceptions: The candidate shall have completed a minimum of one year's successful teaching experience in either agriculture or home economics. The faculty of the Department of Agricultural Education and the School of Home Economics shall be the judge for the acceptability of the candidate's experience record. A thesis is not required, but all candidates for the degrees shall complete a research problem.

A total of 32 units of course work shall be required for the degrees with a minimum of 20 units in a major field and the remainder in supporting subjects. The major fields of study shall include Agriculture and Agricultural Education or Home Economics and Home Economics Education. The additional course work shall be in business administration, education, psychology, sociology and other approved subjects appropriate to the student's need. In addition to the oral examination, a comprehensive written examination in the candidate's major field of study will be required.
MASTER OF BUSINESS ADMINISTRATION

The degree of Master of Business Administration is conferred upon satisfactory completion of a professional postgraduate program in business administration. This program is designed to give students comprehensive training to qualify them for eventually filling positions on the executive level in business. Those who wish to become specialists in one field of concentration in business administration should elect to pursue the program leading to the degree of Master of Science with a major in business administration.

The program for the M.B.A. degree is divided into two parts: a one-year basic core curriculum corresponding roughly to the requirements of an undergraduate major in business administration, and a group of professional and research courses from which may be selected a well-balanced second-year program of courses with graduate credit amounting to not fewer than 30 hours.

It is possible for students to finish the M.B.A. program in two years even though they have had no previous work in the required fields of study. Students may finish the program in fewer than two years if they have completed with satisfactory grades a part of the program.

Requirements for the M.B.A. degree in regard to time limitation, scholarship requirements, approval of program of study, advancement to candidacy, and residence requirements are the same as those for the M.S. degree.

No thesis is required for the M.B.A. degree, but an oral comprehensive examination at completion of the program is required.

CURRICULUM REQUIRED OF ALL STUDENTS WORKING FOR THE M.B.A. DEGREE

First Year. — The following courses must be included in the student’s first-year program, or they (or their equivalents) must have been completed in his undergraduate program:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acctg. 1a (Prin. of Acctg.) or Acctg. 251 (Survey)</td>
<td>3</td>
<td>Acctg. 1b (Prin. of Acctg.) or Acctg. 252 (Managerial Acctg.)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 220a (Business Law)</td>
<td>3</td>
<td>B.A. 220b (Business Law)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 155* (Stat. Methods)</td>
<td>3</td>
<td>B.A. 241 (Business Finance)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 272 (Prin. of Mgmt.)</td>
<td>3</td>
<td>B.A. 261 (Marketing Prin.)</td>
<td>3</td>
</tr>
<tr>
<td>Econ. 291 (Interm. Econ. Theory)</td>
<td>3</td>
<td>Econ. 248 (Money and Banking)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

Second Year. — The five following courses must be completed for graduate credit, with satisfactory grades, by each candidate for the M.B.A. degree, as in part comprising the total 30 required units. Of the remaining 15 units, no more than 9 may be in a single field of concentration.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Econ. 308 (Managerial Economics)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 302 (Employer-Employee Relations)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 355 (Research Methods)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 371 (Business Policies)</td>
<td>3</td>
</tr>
<tr>
<td>B.A. 372 (Adm. Report Writing)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

MASTER OF EDUCATION

The degree of Master of Education will be conferred upon professional students in the field of education who have met the admission requirements of the Graduate College and who have completed the stipulated graduate studies and met all other requirements for the degree. All general regulations for graduate work and all requirements for Master of Arts and Master of Science degrees apply to this degree, except as they may be modified by the following requirements: (A thesis is not a part of the requirements for this degree.)

* In 1959-60, this course will be B.A. 255, 4 units.
Course requirements. — Course work required shall be not less than 32 units. A minimum of 17 units must be in the major subjects.

Supporting work. — If the major is English, mathematics, or other subjects which are teaching fields in the public schools, the supporting work shall include not fewer than 12 semester hours in education. If the major is education, supporting work should be planned with a view to the student’s special interests as a teacher or administrator.

Program of study. — Not later than the beginning of the final semester or term, and preferably at the end of the first term of study, each student shall submit a program of study on a form provided by the Graduate College.

Research project. — All candidates for the degree, whether the major or the minor is in education, are required to complete a research project of a kind to warrant 3 units of credit. Students will register for Education 390 to receive credit for this project.

Written examinations. — All candidates will be required to pass a comprehensive written examination in education and, at the option of the department, a comprehensive written examination in the major field if other than education. Results of such examinations shall be certified to the Graduate Council by the departments.

Oral examination. — An oral examination in the major and supporting subjects is required. A committee for the oral examination shall be appointed by the dean of the Graduate College and shall include not fewer than two representatives of the major and one representative of a minor department. It is the student’s responsibility to ascertain from the departments concerned the manner in which the examination will be conducted. If the examination is unsatisfactory, a second examination may be scheduled after the lapse of one calendar year. No student will be permitted a third examination.

MASTER OF ELECTRICAL ENGINEERING AND MASTER OF MECHANICAL ENGINEERING

The degree of Master of Electrical Engineering and the degree of Master of Mechanical Engineering will be conferred upon students pursuing their profession in industry or in government service who have met the admission requirements of the Graduate College, who have completed the stipulated graduate studies, and who have met all other requirements for the degree. All general regulations for graduate work and all requirements for Master of Science degrees apply to these degrees except as modified by the following requirements:

Thesis requirement. — The thesis is optional. The decision to include or omit the thesis will be made by the head of the department after consultation with the student.

Course requirements. — A minimum of 30 units of work, including the thesis, is required. A minimum of 32 units of work is required if no thesis is submitted.

Transfer to Master of Science program. — Students who have completed not more than 12 graduate semester units in the M.E.E. or M.M.E. program may petition the Graduate Council for candidacy for the Master of Science degree, provided that they offer a program of study which includes at least 18 units of residence credit taken on the campus of the University of Arizona.

MASTER OF FINE ARTS

The art department offers graduate courses leading to the degree of Master of Fine Arts. The degree is designed for students who wish to prepare themselves professionally in the field of art. Students will be admitted to the program who have completed an undergraduate major in art and who have submitted examples of their work judged acceptable by the faculty of the department. However, students who have received bachelors’ degrees from institutions whose requirements differ from those of this institution may be required to take undergraduate
courses to make up such deficiencies as shall be determined by the major professor. Otherwise the requirements are the same as those outlined above for the degree of Master of Arts or Master of Science, with the following exceptions: The unit requirement for the degree is sixty units, which must ordinarily be taken in residence. Further, an original work of art must be offered in lieu of a thesis, and must be accompanied by all sketches, preliminary works, organized annotations of research, and other materials connected with its accomplishment, together with a written essay setting forth the method of procedure and containing a reproduction or reproductions of the work. The department reserves the right to retain for its departmental collection the work submitted. The candidate may be required to prepare a one-man exhibit of his work or to participate in a group exhibit during his last semester in residence.

**MASTER OF MUSIC**

A preliminary comprehensive examination is required of all students working toward the Master of Music degree before they can be admitted to full graduate standing. Course requirements in the several majors are as follows:

<table>
<thead>
<tr>
<th>Major in Applied Music</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Music 317</td>
<td>12 units</td>
</tr>
<tr>
<td>Music Theory</td>
<td>4 units</td>
</tr>
<tr>
<td>Music Literature or Music Education</td>
<td>6 units</td>
</tr>
<tr>
<td>Music Electives</td>
<td>8 units</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30 units</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major in Composition*</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Music 410 (Original composition)</td>
<td>8 units</td>
</tr>
<tr>
<td>Applied Music</td>
<td>4 units</td>
</tr>
<tr>
<td>Conducting 331</td>
<td>2 units</td>
</tr>
<tr>
<td>Compositional Techniques 235</td>
<td>6 units</td>
</tr>
<tr>
<td>Music Electives</td>
<td>10 units</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30 units</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major in Theory*</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Music 410</td>
<td>4 units</td>
</tr>
<tr>
<td>Music 235</td>
<td>6 units</td>
</tr>
<tr>
<td>Music 237</td>
<td>2 units</td>
</tr>
<tr>
<td>Applied Music</td>
<td>4 units</td>
</tr>
<tr>
<td>Music 299 or 399</td>
<td>2 units</td>
</tr>
<tr>
<td>Music Electives</td>
<td>12 units</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>30 units</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major in the History and Literature of Music</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The requirements for the Master of Music degree with a major in the history and literature of music are the completion of 30 units of approved graduate study, with not fewer than 15 units of music selected from courses in music history and literature, theory, applied music, and thesis. The remaining units may be in music or other appropriately related subject areas. The prerequisite for the degree is the B.A. degree with a major in music or the B.M. degree with a major in music history and literature. A reading knowledge of German or French is required before the student may apply for candidacy.</td>
<td></td>
</tr>
</tbody>
</table>

**MASTER OF MUSIC EDUCATION**

The requirements for the Master of Music Education degree are the completion of 32 units of approved graduate study with not fewer than 20 units in music, the remaining units to be in music or other appropriately related subject areas.

A preliminary comprehensive examination is required of all students working for the Master of Music Education degree before they can be admitted to full graduate standing. This examination together with personal interviews enables the major professor to plan a program of study for the student which will meet both his individual interests and professional needs.

Each candidate will be required to complete ONE of the following options: a professional paper; a field study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; the preparation and conducting of a major work in public performance for band, orchestra, or choir.

*Graduate students desiring to major in theory or composition must establish piano proficiency.*
MASTER OF PUBLIC ADMINISTRATION

The degree of Master of Public Administration will be conferred upon completion of programs designed to give advanced training in general governmental administration at the national, state, and local levels; in criminology and correctional administration; in probation-parole administration; and in the fiscal or business administration of public school systems. In the latter field, the degree of Master of Education, may alternatively, be conferred.*

Admission, residence, candidacy, and final examination requirements are the same as those required of candidates for the Master of Arts and Master of Science degrees with the exceptions cited below. Undergraduate work should preferably include background courses in public administration and related subject matter.

Course requirements. — Course work (excluding credit given for thesis preparation or internship) must include a minimum of 30 hours; the number of hours required in a specialized field will be prescribed by the appropriate major professor for each student at the time he submits a program of study.

Thesis-internship. — Either a written thesis or an approval internship in a governmental or private agency in Arizona or elsewhere will be required. Appropriate course credit will be given in either case.

Final examination. — The required final examination may be related either to the thesis or to the internship.

* Beginning in 1960-61, this degree will be offered in the field of metropolitan regional planning, with course work offered cooperatively by the College of Fine Arts (architecture), the College of Engineering (civil engineering), and the College of Business and Public Administration (urban economics).
REQUIREMENTS FOR DOCTORS' 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 as a certificate of faithful performance of a prescribed program of studies and research.

Residence and credit requirements. — Not fewer than six semesters of essentially full-time graduate study are required. Graduate credit earned at approved institutions, if accepted by the major department and the Graduate Council, may be counted toward requirements for the higher degree. However, two regular semesters must be spent in actual residence at the University of Arizona, and at least 30 units must be completed at this university. Any semester during which a student is registered for at least nine units of graduate course work or research will be counted as full residence, provided that the student's full time is devoted to graduate work. The dissertation is understood to require at least one year of full-time work. Dissertation credit of not more than 18 units is allowed for research on the dissertation problem. If the dissertation is to be written in absentia, arrangements must be made through petition to the Graduate Council with the favorable recommendation of the department supervising the work. All requirements for the degree, including work done for the master's degree, must be met within a period of ten years.

Major and minor subjects. — The student shall choose a major subject and either one or two supporting minor subjects. The minor subject or subjects must be taken outside the department of the major subject. Not fewer than 36 units of work exclusive of the dissertation, must be in the area of the major subject.

Qualifying examination. — For the purpose of demonstrating his fitness to undertake work leading to candidacy for the doctorate, each prospective candidate must pass a qualifying examination covering work done previously in the proposed major and minor fields. 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 must be taken during the first semester of residence and preferably should be taken during the first two weeks of residence.

Program of study.— A program of study recommended by the department or departments concerned and an outline of the proposed dissertation, approved by the major department, must be approved finally by the Graduate Council. The program and the outline should be submitted on forms provided by the dean, the program at the beginning of the second year of graduate study, and the outline not later than eight months prior to completion of degree requirements (September 15 for those completing requirements in May).
REQUIREMENTS FOR DOCTORS' DEGREES

Foreign language requirement.—Before the preliminary examination the departments of French and German must certify that the student is proficient in these languages for the purposes of research. With the approval of the major department and the Graduate Council, proficiency in another language may be substituted for proficiency in one of these.

Preliminary examination.—Before admission to candidacy for the degree, the student must pass a general examination in his chosen field 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 examinations covering the major and minor fields and, upon successful completion of these, an oral examination which shall be conducted before a committee of the faculty appointed by the dean upon consultation with the major and minor departments. This examination will be held toward the end of the second year of graduate work and in any case not later than three months prior to the date of the final oral examination. Except by special permission of the dean, it may not be taken until the minor work has been completed.

Advancement to candidacy.—When the student has passed the preliminary examination, has satisfied the language requirements, and shown evidence of ability to carry on research work of a high grade, he will be recommended to the Graduate Council for acceptance as a candidate for the doctorate. These regulations must be met not later than three months prior to the date of the final oral examination.

Dissertation.—Two weeks prior to the date of the final examination, one copy of the dissertation and two copies of an abstract of the dissertation, all approved and accepted by the major department, must be submitted to the Graduate Council through the office of the dean. Immediately following the final examination, two copies of the dissertation (including the one previously submitted), approved and accepted by the major department and the examining committee must be filed with the dean, and a binding fee of $5 must be paid to the University Comptroller. The major department, at its option, may require a third copy for the department files.

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 his final examination, and the dean of the Graduate College, the typed first copy and an abstract of 700 words or less, are forwarded to University Microfilms. The manuscript is microfilmed, and the negative inspected and put in vault storage. The manuscript is catalogued and this information is sent to the Library of Congress for printing and distribution of cards to depository catalogues and libraries. The abstract is printed in the forthcoming issue of Microfilm Abstracts and distributed to leading libraries here and abroad, and to a selected list of journals and abstracting services. The first copy with one positive microfilm is then returned to the University of Arizona Library.

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

Final examination.—When the required standards of scholarship have been met and the required ability in research has been shown, the candidate shall submit to an oral examination in defense of his dissertation, as well as any general questioning related to his field of study which may develop therefrom. This examination, the exact time and place to be announced at least one week in advance, shall be conducted before a committee of the faculty appointed by the dean upon consultation with the major and minor departments, and shall be open to the public.

Other examinations.—Before admittance to the final examination and in addition to the preliminary examination and the regular, scheduled course examinations, the candidate may be required to take any other examinations, oral or written, thought proper by the departments concerned.
SPECIAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE UNDER THE PLANT SCIENCE PROGRAM

Study and investigation in plant science, emphasizing fundamental work leading to the degree of Doctor of Philosophy, is conducted with a major in one of the following fields of specialization: agricultural chemistry and soils, agronomy, botany, entomology, horticulture, plant breeding, plant pathology, range management, and wildlife management. Supporting studies may be undertaken in these or related fields fundamental to the training of the candidate. The major field of specialization shall be listed together with the words Plant Science Program on the transcript.

The plant science doctoral program is coordinated by a Plant Science Graduate Committee consisting of one representative from each of the above-mentioned fields. This committee has as its main purpose to strengthen and broaden the plant science doctoral program.

Each candidate for the degree of Doctor of Philosophy in plant science shall be under the immediate direction of a Guidance Committee. This Guidance Committee, selected by the major department of the candidate, subject to the approval of the Graduate Council, shall consist of a dissertation director, who shall be the chairman, and two or more additional members. At least three departments shall be represented on the Guidance Committee, the exact personnel being determined by the fields of interest of the candidate. The Guidance Committee will give the qualifying examination and will serve as members of the preliminary and final examination committees.

DOCTOR OF EDUCATION

The Department of Education of the Graduate College accepts prospective candidates for the degree of Doctor of Education. The degree is granted only to those who demonstrate a high degree of proficiency in education and who present a dissertation of a professional nature. (For the requirements for the degree of Doctor of Philosophy, see page 42.)

Residence and credit requirements. — The equivalent of three academic years of essentially full-time graduate study, including work toward a master's degree, is required. Graduate credit earned at approved institutions may be counted toward requirements for this degree, if accepted by the Department of Education and the Graduate Council, but the equivalent of at least one academic year of full-time work must be completed at this university; and at least one regular semester beyond the master's degree must be completed in residence. Any semester during which the student is registered for at least nine units of course work or research will be counted as full residence, provided that the student's full time is devoted to graduate work. The dissertation is understood to require at least one academic year of full-time work. Dissertation credit of not more than 18 units is allowed and not more than nine such units may be earned in a single semester. If the dissertation is to be written in absentia, arrangements must be made through petition to the Graduate Council with favorable recommendation of the Department of Education. Requirements for the Doctor of Education degree must be completed within a period of six calendar years after the qualifying examination.

Major and minor subjects. — The student will major in education but must have a minor in a department other than education. Not less than 46 units of work, exclusive of dissertation, must be in education.

Qualifying examination. — For the purpose of demonstrating fitness to undertake work leading to candidacy for the doctorate, each applicant must pass a qualifying examination. It is expected that this examination will be taken after 30 hours and before 45 hours of graduate work have been completed. The examination will be either oral or written, or both, at the discretion of the department. In addition to personal interview, a review of the applicant's college record, and evidence of the applicant's ability to write in a scholarly manner are required. Applicants may offer the master's thesis or an equivalent paper to the examining committee for its use in evaluating their ability to write in acceptable fashion.

Teaching experience. — Candidates for the degree of Doctor of Education are required to furnish evidence of at least three years of successful teaching or administrative experience in the public schools.
Advisory committee. — When the student has successfully passed the qualifying examination and has outlined a tentative dissertation problem, the dean of the Graduate College, after consultation with the dean of the College of Education, will appoint an advisory committee. Two members from the student's major field of study and one from his minor field of study will constitute the committee. The chairman will be the student's major professor and dissertation director. The duties of this committee are to review the proposed dissertation problem, to evaluate the student's program of study, to make recommendations to the dean of the College of Education concerning the dissertation problem and the program of study and to be available to the student when guidance is necessary.

Program of study. — A program of study, recommended by the dean of the College of Education, must be submitted for the approval of the Graduate Council at the beginning of the second year of graduate study. An outline of the proposed dissertation, approved by the dean of the College of Education, must be submitted for the approval of the Graduate Council not later than eight months prior to the date of the final oral examination. The appropriate forms are available in the office of the dean of the Graduate College.

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

Preliminary examination. — Before admission to candidacy for the degree, the student must pass a comprehensive examination. This examination shall be both written and oral and will cover work which the applicant has taken in education and in minor fields. The oral examination shall be conducted before a committee of the faculty appointed by the dean of the Graduate College upon consultation with the dean of the College of Education and the head of the minor department. The examination will be held toward the end of the second year of graduate work and in any case not later than three months prior to the final oral examination.

Advancement to candidacy. — When the preliminary examination has been passed and evidence shown 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.

Final examination. — When he has met the required standards of scholarship and has shown the required ability in research, the candidate shall submit to an oral examination in defense of his dissertation, as well as to any general questioning related to his field of study which may develop therefrom. This examination shall be conducted before a committee appointed by the dean of the Graduate College upon consultation with the dean of the College of Education, the exact time and place to be announced at least one week in advance, and shall be open to the public.

Dissertation. — Two weeks prior to the date of the final examination, one copy of the dissertation and two copies of an abstract of the dissertation, all approved and accepted by the major department, must be submitted to the Graduate Council through the office of the dean. Immediately following the final examination, two copies of the dissertation (including the one previously submitted), approved and accepted by the major department and the examining committee, must be filed with the dean, and a binding fee of $5 must be paid to the University Comptroller. The major department, at its option, may require a third copy for the department files.

Publication of dissertation. — Dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee of $25 is charged to cover this expense. Upon certification by the student's major professor, members of the committee of his final examination, and the dean of the Graduate College, the typed first copy and an abstract of 700 words or fewer are forwarded to University Microfilms. The manuscript is microfilmed and the negative inspected and put in vault storage. The manuscript is catalogued and the catalogue information sent to the Library of Congress for printing and distribution of cards to depository catalogues 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 with one positive microfilm is then returned to the University of Arizona Library.
UNIVERSITY OF ARIZONA RECORD

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

DOCTOR OF MUSICAL ARTS

The School of Music of the Graduate College accepts prospective candidates for the degree of Doctor of Musical Arts. The degree is granted only to those who do outstanding work in the field of music composition, music education, or music performance and who present an acceptable dissertation. It is not granted merely as a certificate of faithful performance of a prescribed program of studies but requires demonstration of truly distinguished attainment.

Residence and credit requirements. — The equivalent of three academic years of essentially full-time graduate study, including work toward a master's degree, is required. If accepted by the School of Music and the Graduate Council, graduate credit earned at other approved institutions may be counted toward equivalents for this degree. However, two regular semesters must be spent in actual residence at the University of Arizona (three semesters for the major in performance), and at least 30 units must be completed at this university. In certain cases, the residence requirement may be met by attending a full summer session (both terms) in addition to the preceding spring semester or the following fall semester. Any semester during which a student is registered for at least nine units of graduate course work or research will be counted as full residence, provided that the student's full time is devoted to graduate work. The dissertation is understood to require at least one academic year of full-time work. Dissertation credit of not more than 18 units is allowed and not more than nine such units may be earned in a single semester. If the dissertation is to be written in absentia, arrangements must be made through petition to the Graduate Council with favorable recommendation of the School of Music. All requirements for the Doctor of Musical Arts degree, including work for the master's degree, must be met within a period of ten calendar years.

Major and minor subjects. — The student will major in music composition, music education, or music performance, but must have a minor in a department other than music. Not fewer than 36 units of work, exclusive of dissertation, must be in the field of music.

Qualifying examination. — For the purpose of demonstrating fitness to undertake work leading to candidacy for the Doctor of Musical Arts degree, each applicant must pass a qualifying examination covering work done previously in the proposed major and minor fields. For the major in composition or performance, this examination must be taken during the first semester in residence, preferably during the first two weeks. For the major in music education, it should be taken after 30 hours and before 45 hours of graduate work have been completed. The examination may be waived at the discretion of the School of Music for a student who has completed a master's degree in music at the University of Arizona. In addition, a personal interview, a review of the applicant's college record and musical achievement, and evidence of his ability to write in a scholarly manner are required.

Advisory committee. — For each student entering the program leading to the Doctor of Musical Arts degree, the dean of the Graduate College, after consultation with the director of the School of Music, will appoint an advisory committee. Two members of the faculty of the School of Music, one of whom shall be designated as the student's major professor and one member of the department of the student's minor field of study will constitute the committee. The chairman will be the student's major professor and dissertation director. The committee will review and evaluate the student's previous preparation, advise the student with respect to an appropriate program of study, make recommendations to the director of the School of Music concerning the dissertation problem, and be available to the study when guidance is necessary.

Program of study. — A program of study, recommended by the director of the School of Music, must be submitted for the approval of the Graduate Council at the beginning of the second year of graduate study. An outline of the proposed dissertation, approved by the director of the School of Music, must be submitted for the approval of the Graduate Council not less than eight months prior to the date of the final oral examination. The appropriate forms are available in the office of the dean of the Graduate College.
Foreign language requirement. — A reading knowledge of one foreign language is required. The specific language required will be determined by the student's Advisory Committee.

Preliminary examination. — Before admission to candidacy for the degree, the student must pass a comprehensive examination. This examination shall be both written and oral and shall cover work which the applicant has taken in music and in minor fields. The oral examination shall be conducted before a committee of the faculty appointed by the dean of the Graduate College upon consultation with the director of the School of Music and the head of the minor department. The examination will be held toward the end of the second year of graduate work and in any case not later than three months prior to the final oral examination.

Advancement to candidacy. — When he has passed the preliminary examination and has given 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 not later than three months prior to the final oral examination.

Final examination. — When he has met the required standards of scholarship and has shown the required ability in research, the candidate shall submit to an oral examination in defense of his dissertation, as well as to any general questioning related to his field of study which may develop therefrom. This examination shall be conducted before a committee appointed by the dean of the Graduate College upon consultation with the director of the School of Music, the exact time and place to be announced at least one week in advance, and shall be open to the public.

Other examinations. — Before being admitted to the final oral examination and in addition to the preliminary examination and the regularly scheduled course examinations, the candidate may be required to take any other examinations, oral or written, that are thought proper by the School of Music.

Dissertation. — Two weeks prior to the date of the date of the final examination, one copy of the dissertation and two copies of an abstract of the dissertation, all approved and accepted by the School of Music, must be submitted to the Graduate Council through the office of the dean. Immediately following the final examination two copies of the dissertation (including the one previously submitted), approved and accepted by the major department and the examining committee, must be filed with the dean, and a binding fee of $5 must be paid to the University Comptroller. The School of Music, at its option, may require a third copy for its files.

Publication of dissertation. — Dissertations are published by University Microfilms, Ann Arbor, Michigan, and a fee of $25 is charged to cover this expense. Upon certification by the student's major professor, members of the committee for his final examination, and the dean of the Graduate College, the typed first copy and an abstract of 700 words or less are forwarded to University Microfilms. The manuscript is microfilmed, the negative inspected, and put in vault storage. The manuscript is catalogued and this information is sent to the Library of Congress for printing and distribution of cards to depository catalogues 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 and one positive microfilm is then returned to the University of Arizona Library.

Publication by microfilm does not preclude publication by other methods later, and successful candidates are urged to submit dissertation material for publication through appropriate media. Suitable 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 Musical Arts at the University of Arizona.

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. This may be demonstrated by submission of several compositions in large form for ensemble or orchestra.
The student majoring in composition will, in lieu of a dissertation, write a large scale composition requiring not less than half an hour in performance and scored for full or chamber orchestra (with or without soloists) or for voice and orchestra. A written analysis of the formal, stylistic, and technical elements for the composition must accompany the work.

**Specific requirements for the major in music education.** — Applicants for the Doctor of Musical Arts degree in music education will be required to furnish evidence of at least three years of successful teaching or administrative experience in the field of music either in the public schools or at the college level.

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

**Special requirements for the major in performance.** — Shortly after beginning his graduate work, the applicant shall present a recital which will serve as part of the qualifying examination for admission to the degree program with a major in performance.

The student majoring in performance must spend at least three regular semesters in residence. Two semesters must be consecutive and the third will normally be the semester during which the student completes the requirements for his degree.

The student shall write a scholarly document showing his ability to accomplish independent research. This document must deal adequately with such matters as source materials, comparative editions, score analysis, and performance praxis. The student shall also give a lecture recital and use his medium of performance to illustrate it. In addition, he shall appear as a performer within a chamber group or as an accompanist. The program must include literature composed before 1800 as well as 19th and 20th century music.

As a part of his final examination, the candidate shall give a public recital of at least one hour's performance time. The oral examination, to be held within ten days following the recital, will be directed to the recital and to discussion of the document referred to above as well as to any related matters the examining committee may deem appropriate.
COURSES OF INSTRUCTION

EXPLANATORY NOTES

Descriptions of all courses carrying graduate credit may be found on the following pages. Departments are arranged alphabetically, rather than with respect to college organization. (See Table of Contents for departmental listings.)

Classification of courses. — In all colleges the number by which a course is designated is intended to indicate the relative advancement of the course. Courses numbered 1 to 99 inclusive are primarily lower-division courses for freshmen and sophomores. Courses numbered 100-199 inclusive are upper-division courses primarily for juniors and seniors. Courses numbered 200 to 299 inclusive may be carried for upper-division credit by qualified juniors and seniors and for graduate credit by graduate students with the approval of the dean of the Graduate College. These courses are not open to lower-division students. Courses numbered 300 to 399 inclusive are for graduate students, but exceptionally well-qualified seniors may be admitted to certain courses in this group with the approval of the instructor and the dean of the Graduate College. Courses numbered 400 and above all involve research, internship, thesis, or dissertation and are exclusively for graduate students.

Students doing independent work or special problems which cannot be classified as actual research will register for credit under course number 299. Course number 400 is used in all departments for registration for credit for research which is not related to a thesis or dissertation the student will write for an advanced degree. The number 410 is used in a like manner for the doctoral dissertation. Acceptable performance in these courses (and for 399 Seminar and 405 Internship) is indicated by the grade pass or superior. Since number grades are not used for passing work, passing grades in these courses are not included in the calculation of grade averages.

Courses numbered 100-199 in the College of Law may be carried for graduate credit with the consent of the dean of the College of Law and the dean of the Graduate College.

Year courses (double numbers). — A course designated by a double number (as Mathematics 304a-304b) is continued through two successive half-years, the work of the first semester being prerequisite to that of the second semester unless otherwise indicated in the statement of prerequisites. The student will use the first number in registering for the course during the first semester and the second number in registering for the course during the second semester. A final report will be made by the instructor at the end of each semester, with final credit for the first half of the course except as otherwise noted.

Semester courses (single numbers). — A course designated by a single number (as Mathematics 382) is one semester in length.

Prerequisites. — A student registering for a course must meet the prerequisite or otherwise satisfy the instructor of his ability to take the course.

Cancellation of courses. — The faculty reserves the right to cancel any course not elected by an adequate number of students.
KEY TO SYMBOLS

( ) Indicates the unit value of the course for each semester by the number in parenthesis following the course title. Each unit usually represents one lecture or recitation or 3 hours of laboratory work per week for a semester.

I, II. Indicates the half-year during which a semester course is offered (i.e., "I," first semester; "II," second semester; "I, II," both semesters).

Yr. Indicates the course is given throughout the year, the first half of the course being offered in the first semester, the second half in the second semester. Where one or both halves of a year course are offered each semester, this is indicated in the course description.

200-299 Indicates that the course may be carried for graduate credit under arrangements approved by the instructor, by the head of the department, and by the dean of the Graduate College. Courses thus designated are not open to lower-division students or to regular unclassified students with less than 56 college credits.

1959-60 1960-61 Indicates that the course is an alternate-year course, to be offered during the year designated.

R, L. Indicates "recitation" and "laboratory." For those courses which include laboratory work, the number of hours of recitation and laboratory work is listed on the basis of hours per week (i.e., "2R, 3L"). For courses consisting of lecture and recitation periods only, the number of class hours per week is the same as the unit value of the course.

P. Indicates "prerequisite."

CR. Indicates "concurrent registration."
The Department of Accounting offers graduate instruction leading to the professional degree, Master of Accounting. For information concerning requirement for this degree, see page 37.

201. Advanced Accounting (3) I, II Myers
Partnerships; joint ventures; special problems of consignments, installment sales, and insurance; insolvent concerns; estates and trusts. P, 1b.

202. Consolidated Statements (3) I Myers
Accounting for domestic and foreign branches; parent and subsidiary corporations, with special emphasis on the preparation of consolidated balance sheets and income statements; consolidations and mergers. P, 101a or 102.

211. Advanced Cost Accounting (3) II Foltz
Concepts and applications of standard costs for control of manufacturing, distribution, and administrative costs; analysis and use of cost data as an aid to operational control and profit planning. P, 111.

221. Income Tax Procedure (3) I, II Bogart-Raby
Interpretation of income tax laws, rules, and regulations of the United States and the state of Arizona with particular emphasis on fundamentals of the tax laws and procedures applicable to individual returns. P, 1b.

241. Governmental and Institutional Accounting (3) II Baughman
Budgetary accounting and financial control and their application to various governmental units, more particularly cities, counties, other local political subdivisions, and public institutions. P, 1b or 251.

251. Survey of Accounting (3) I, II Staff
Primarily for students desiring a general knowledge of the field of accounting. Concepts and mechanisms of accounting; emphasis on the uses of accounting as a means of managerial control in industrial enterprises. Not open to students of whom Accounting 1a-1b is required.

252. Managerial Accounting (3) I, II Staff
Designed to acquaint users of accounting data with a knowledge of those basic accounting concepts and analytical procedures necessary to an understanding of accounting reports used in management planning and control. Not open to students who are majoring in accounting or who have credit for Accounting 101b or 102. P, 1b or 251.

253. Business Budgeting (2) I Raby
Relationship of budgeting to management functions; principles and procedures of profit planning and financial control for both manufacturing and non-manufacturing organizations. P, 1b or 251.

261a-261b, Accounting Systems (2-2) Yr. Thierman
Steps in the design and installation of accounting systems; use of codes; provision for internal checks and controls; special problems of small businesses; systems reports and manuals; punched card accounting. P, 101b or 102, and 111.

301. Accounting Theory (3) I Staff
A study of the development of accounting thought; critical analysis of current accounting theory and practice; selected readings on specialized topics; study of AICPA Accounting Research Bulletins. P, 101b or 102, and 111.

302a-302b. Advanced Problems in Accounting (2-2) Yr. Myers
Advanced accounting problems selected primarily with the view of preparing candidates for the practice section of the C.P.A examination. P, 101b or 102, 201, and 211. 302a is not a prerequisite to 302b.
321. Advanced Income Tax Procedure (3) II
Interpretation of income tax laws, rules, and regulations with particular emphasis on partnerships, corporations, reorganizations, fiduciaries, and gift taxes. P, 191a, 102, 201 or CR and 202.

331a-331b. Auditing Theory and Practice (3-3) Yr.
Qualifications, duties, and responsibilities of the professional auditor; principles of auditing, developing of auditing techniques; preparation of working papers and reports, recent legislation and its effect on auditing procedure. P, 101b or 102 and 111.

341. Ethics and Responsibilities of the Accountant (3) I
A professional course for those who expect to pursue public accounting as a career. A study of the ethics of the AICPA and applicable Arizona law; legal responsibilities of the public accountant with reference to short-form, long-form, and special reports. P, 331b.

342. Tax Planning & Practice (3) II
Scope of activity, responsibility, and ethics of the C.P.A. in the tax field; principles and techniques in minimizing income taxes; procedures in tax practice from return preparation through docketing a case with the Tax Court. Discussion and case analyses in class will be supplemented by extensive individual reading and research. P, 321.

399. Seminar in Accounting (2-4) I, II
Open to seniors with consent of instructor. Content confined to some special field of accounting, depending on student need and availability of faculty.

INDIVIDUAL STUDIES

299. Special Problems (1-5) I, II
400. Research (2-4) I, II
410. Thesis (4-6) I, II Maximum total credit permitted, 6 units.

AERO-SPACE ENGINEERING

(See Mechanical Engineering)

AGRICULTURE

Study leading to the Master of Science degree is available in agricultural chemistry and soils, agricultural economics, agricultural engineering, agronomy, animal nutrition, animal science, botany, dairy science, entomology, horticulture, nutrition, plant pathology, poultry science, range management, and watershed management. The degree of Master of Agricultural Education is offered by the Department of Agricultural Education.

Study leading to the Doctor of Philosophy degree under the Plant Science Program is available in agricultural chemistry and soils, agronomy, botany, entomology, horticulture, plant breeding, plant pathology, range management, and wildlife management. For further information see page 44.

In addition to the usual classroom and laboratory facilities, there is available to the graduate student in agriculture the opportunity of participating in actual agricultural research in progress in the Agricultural Experiment Station. Each student is normally assigned to a staff member of the Agricultural Experiment Station, under whose direction he conducts the research necessary to the writing of an acceptable thesis.

The Bachelor of Science degree in the undergraduate major, or its equivalent, is normally required for admission to graduate work in a particular field. By special permission, a field of concentration in the undergraduate work different from, but related to, the graduate major may be acceptable.

See page 38 for Master of Education degree major or minor in these departments.
For further detailed information about graduate programs in agriculture see the following department headings:

- Agricultural Chemistry
- Animal Pathology
- Poultry Pathology
- Animal Science
- Botany
- Dairy Science
- Enormology
- Horticulture
- Plant Breeding
- Agriculture and Soils
- Agronomy
- Agricultural Economics
- Agricultural Education
- Agricultural Engineering
- Agricultural Education

Certain courses of general interest in a number of subject matter areas are not assigned to any specific department. Of these, the following are available for graduate credit:

230. Principles of Agricultural Research (1) I
    H. Tucker
    An introduction to the scientific method, principles, and techniques of research, and effective presentation of results.

235. Sample Survey Methods (3) II
    H. Tucker

237a-237b. Statistical Methods in Agriculture (3-3) Yr.
    H. Tucker

339. Design of Experiments in Agriculture (3) I
    H. Tucker
    Increasing precision and accuracy of experiments, complete and incomplete block designs, factorial experiments and confounding, response surface designs. P, 237a-237b.

AGRICULTURAL BIOCHEMISTRY

Committee on Biochemistry and Nutrition (Graduate)

Professors Arthur R. Kemmerer, Ph.D., Chairman, Wallace H. Fuller, Ph.D. (Agricultural Chemistry), Albert L. Piccioni, Ph.D. (Pharmacy), Raymond E. Reed, Ph.D. (Animal Pathology), John W. Stull, Ph.D. (Dairy Science), Ethel M. Thompson, Ph.D. (Home Economics), Mitchell G. Vavich, Ph.D. (Agricultural Biochemistry)

Associate Professor William J. McCauley, Ph.D. (Zoology)

Assistant Professors James W. Berry, Ph.D. (Chemistry), Eugene S. Erwin, Ph.D. (Animal Science)

Graduate work leading to a Master of Science degree or a Doctor of Philosophy degree with a major in agricultural biochemistry is offered. The minor subject may be bacteriology, botany, physiology, pharmacology, or the various branches of chemistry. Representatives from Agricultural Biochemistry, Agricultural Chemistry and Soils, Animal Pathology, Animal Science, Chemistry, Dairy Science, Home Economics, Poultry Science, Pharmacy, and Zoology make up the Committee on Biochemistry and Nutrition. The course of study of the candidate will be selected by the thesis director and approved by the Committee on Biochemistry and Nutrition. The prerequisite is a bachelor's degree in biological science, chemistry, agriculture, or home economics, including not fewer than six units in organic chemistry, four units in biochemistry or nutrition, and four units in bacteriology or physiology. By approval of the Committee on Biochemistry and Nutrition, deficiencies may be made up after admission to the Graduate College.

214. Intermediary Metabolism (2) II 1960-61
    McCauley
    Enzymatic aspects of intermediary metabolism; biological oxidations; metabolism of nucleic acids and hormones. P, 6 units of organic chemistry; Animal Science 104 or Chemistry 261a-261b or Home Economics 202R, 202L, or Botany 103, Bacteriology 17, Zoology 253a-253b or equivalent.
216. Chemistry of Natural Polymers (2) I
   Deutschman-Kircher
   Occurrence, characterization, physical and chemical properties, functions, and uses
   of natural polymers. 2R, P. Chemistry 140a-b, 284a-b.

301. Advanced Animal Nutrition (3) II 1959-60
   Kurnick
   (Identical with Poultry Science 301)

302. Chemistry and Metabolism of Lipids (2) I 1959-60
   Thompson
   (Identical with Home Economics 302)

306. Dairy Chemistry (3) II 1960-61
   (Identical with Dairy Science 306)

308. Chemistry and Metabolism of Proteins (2) II 1959-60
   Kemmerer
   The chemistry and structure of proteins and amino acids; the chemistry and physiology
   of their metabolism and their biological and chemical evaluations. P, 6 units of
   organic chemistry; Animal Science 104 or Chemistry 261a-261b or Home Economics
   202R, 202L; Bacteriology 17 or Zoology 253a-253b.

310. Vitamins and Minerals (2) I 1960-61
   Vavich
   The chemistry and metabolism of vitamins and minerals. P, 6 units of organic chem-
   stry; Animal Science 104 or Chemistry 261a-261b or Home Economics 202R, 202L
   or equivalent; Bacteriology 17 or Zoology 253a-253b.

312. Chemistry of Enzymes (2) II 1960-61
   Kurnick
   Biochemical and physical principles as applied to the study of properties, functions,
   mode of action, isolation, purification, and identification of enzyme compounds.
   P, Chem. 104b or 40 and 60; Chemistry 261b or Zoology 253b, or Botany 303 or
   Home Economics 202R.

360a-360b. Advanced Biochemistry (3-3) Yr.
   (Identical with Poultry Science 312)
   Berry-Steelink

364. Chemistry of Natural Products (3) II 1960-61
   (Identical with Chemistry 360a-360b)
   Berry-Steelink

366. Mechanisms of Enzyme Action (3) I 1959-60
   (Identical with Chemistry 364)
   Staff

399. Seminar (1) I, II
   (Identical with Chemistry 366)

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 4) I, II
410. Thesis (2 to 4) I, II
420. Dissertation (1 to 9) I, II

The courses listed below also may be taken for credit in biochemistry and nut-
rition. For description, see departments listed elsewhere in catalogue.

AGRICULTURAL CHEMISTRY 321. Radioactive Tracer
   Techniques in Agriculture (3) I 1959-60

BACTERIOLOGY 219a-219b. Infection and Immunity (4-4) Yr.
BACTERIOLOGY 227. Yeasts and Molds (4) I
BACTERIOLOGY 239. Higher Bacteria (4) II
BACTERIOLOGY 317a-317b. Bacterial Physiology (4-4) Yr.
BACTERIOLOGY 327. Viruses (2) I

BOTANY 303. Advanced Plant Physiology (4) I

CHEMISTRY 240. Qualitative Organic Analysis (3) I

CHEMISTRY 242. Organic Reactions (3) II

CHEMISTRY 260a-260b. Biochemistry (3-3) Yr.

CHEMISTRY 261a-261b. Biochemistry Laboratory (2-2) Yr.
CHEMISTRY 280a-280b. Physical Chemistry (3-3) Yr.
CHEMISTRY 281a-281b. Physical Chemistry Laboratory (2-2) Yr.
CHEMISTRY 288. Colloid Chemistry (2) I
CHEMISTRY 320. Advanced Analytical Chemistry (3) II
CHEMISTRY 362. The Carbohydrates (2) II
HOME ECONOMICS 202R. Nutrition (2) I
HOME ECONOMICS 202L. Nutrition Laboratory (2) I
HOME ECONOMICS 222. Readings in Nutrition (2) II
PHARMACY 207a-207b. Organic Pharmaceutical Chemistry (3-3) Yr.
PHARMACY 221a-221b. General Pharmacognosy (4-4) Yr.
PHARMACY 231a-231b. General Pharmacology (4-4) Yr.
PHARMACY 340L. Advanced Pharmacology Laboratory (2) I 1959-60
ZOOLOGY 217. Techniques of Biological Literature and Nomenclature (2) II
ZOOLOGY 229. Parasitology (4) I
ZOOLOGY 253a-253b. Mammalian Physiology (4-4) Yr.

AGRICULTURAL CHEMISTRY AND SOILS

Professors Wallace H. Fuller, Ph.D., Head, Theophil F. Buehrer, Ph.D., Howard V. Smith, M.S., Thomas C. Tucker, Ph.D., Joel Fletcher, M.S., Soil Conservationist
Associate Professors Duwayne M. Anderson, Ph.D., Robert H. Maier, Ph.D.
Assistant Professors Robert R. Binnie, Ph.D., Harold F. Kreizinger, Ph.D., Nicholas Raica, Ph.D., Fred Turner, Ph.D.

The Department of Agricultural Chemistry and Soils offers graduate work leading to the Master of Science and Doctor of Philosophy degrees in the fields of agricultural chemistry and soil science. Opportunity is provided for study in the fields of soil fertility, soil chemistry, physics, microbiology, conservation, and classification. The Doctor of Philosophy degree is offered with soil science as a field of specialization under the plant science program (see page 44).

Students with a bachelor's degree who are well grounded in chemistry, physics, and mathematics, or who have specialized in the plant sciences will be considered for graduate work in the department. Qualifying examinations are required of transfer students. A foreign language is desirable for students pursuing a Master of Science degree and two foreign languages are required of candidates for the Doctor of Philosophy degree.

Majors in the department may minor either in physical sciences (chemistry, physics, and irrigation) or in plant sciences (agronomy, botany, entomology, horticulture, plant breeding, plant pathology, watershed management, and wildlife management).

202. Soil-Plant Relationships and Fertilizers (3) I Tucker
Theories and concepts of soil fertility and soil-plant relationships. Fertilizer properties and reactions of fertilizers in soils. P, one course in soils, preferably 11 or 211.

207. Soil Physics (4) II Anderson
Soil formation, texture, structure, moisture relations, and other physical properties which determine tillage practices. 3R, 3L. P, 11, Physics 2a or 5 or CR. Fee, $6.

211. Soil Chemistry (4) II Maier
The chemical reactions in soils involving the clay minerals, exchangeable bases, acidity, alkalinity, soluble salts, and organic matter which affect plant-food availability. 3R, 3L. P, Chem. 20a. Fee, $6.

221. Soil Microbiology (4) I Fuller
The nature of the soil microflora and its influence on soil fertility. 3R, 3L. P, 211 or Chemistry 140a, and Bacteriology 1a. Fee, $6.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>231</td>
<td>Forest and Range Soils (2) I 1959-60</td>
<td>Binnie</td>
<td>1959-60</td>
<td>Studies of the physical, chemical, and biological properties of soils with special reference to the classification and utilization of soils in forest and range production. P, 11.</td>
</tr>
<tr>
<td>251</td>
<td>Agricultural Chemical Analysis (4) II 1959-60</td>
<td>Raica</td>
<td>1959-60</td>
<td>The analysis of fertilizers, insecticides, agricultural chemicals, and the major plant constituents by the official chemical, colorimetric, chromatographic, and spectrophotometric methods. 2R, 6L. P, Chem. 20a. Fee, $7.</td>
</tr>
<tr>
<td>261</td>
<td>Soil Conservation (3) I 1960-61</td>
<td>Smith</td>
<td>1960-61</td>
<td>Physical and chemical factors affecting soil erosion. Soil conservation practices conducive to a permanent agriculture. 3R. P, 11 or 207. Three-day field trip and occasional half-day field trips. Fee, $6.</td>
</tr>
<tr>
<td>271</td>
<td>Agricultural Hydrology (3) II 1960-61</td>
<td>Fletcher</td>
<td>1960-61</td>
<td>Principles and practices of hydrology as applied to southwestern agriculture with particular emphasis on the aspects which involve soil science. One 4-day field trip and one single-day field trip. P, 306 or Chem. 180 or 280a, Math. 79a-79b. Field trip fee, $5.</td>
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<tr>
<td>305</td>
<td>Theoretical Soil Physics (3) II 1959-60</td>
<td>Anderson</td>
<td>1959-60</td>
<td>Fluid flow in soils, potential theory, and surface phenomena. Introduction to modern concepts and theories of physical processes in soils. P, Chem. 180 or 280a, Math. 79b or 95b.</td>
</tr>
<tr>
<td>399</td>
<td>Seminar (1) I, II</td>
<td>Staff</td>
<td>I, II</td>
<td>Student reports on current topics based on recent literature. Open to qualified seniors.</td>
</tr>
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</table>

**INDIVIDUAL STUDIES**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Year</th>
<th>Credits</th>
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<tr>
<td>299</td>
<td>Special Problems (1 to 5)</td>
<td>I, II</td>
<td>1 to 5</td>
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<tr>
<td>400</td>
<td>Research (2 to 8)</td>
<td>I, II</td>
<td>2 to 8</td>
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<tr>
<td>410</td>
<td>Thesis (2 to 8)</td>
<td>I, II</td>
<td>2 to 8</td>
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<tr>
<td>420</td>
<td>Dissertation (1 to 9)</td>
<td>I, II</td>
<td>1 to 9</td>
</tr>
</tbody>
</table>

**AGRICULTURAL ECONOMICS**

Professors Raymond E. Seltzer, Ph.D., Head, Jimmye S. Hillman, Ph.D., Maurice M. Kelso, Ph.D., Aaron G. Nelson, Ph.D.

Associate Professor Thomas M. Stubblefield, Ph.D.

Assistant Professors Leo J. Moran, Ph.D., Charles A. Wilmot, Ph.D.

The Department of Agricultural Economics offers work leading to the Master of Science degree. The student working toward this degree will select a major field of emphasis from agricultural production economics, agricultural marketing, or agricultural business. A total of 30 semester hours above the bachelor's degree, including an acceptable thesis, is required for the degree. Each graduate student in this department is assigned to a staff member who is currently working on research in the field of the student's interest.
201. Agricultural Prices (3) II  
Trends in prices, price determination, and price estimation. P, 1a or Econ. 1a.  
Seltzer

202. Agricultural Economics Statistics (3) I  
Application and interpretation of statistical measures to problems in agricultural economics. P, Math. 11 or 20 or equivalent.  
Tucker

203. Marketing Farm and Ranch Products (3) I  
Marketing functions, services, costs, and regulatory measures in the movement of agricultural products from the producer to the consumer. P, 1a or Econ. 1a. One 2-day field trip. Fee, $5.  
Hillman

204. Land Economics (3) I  
Economic principles useful in analyzing problems and policies of land and water use, development, and conservation; their application to problems of land and water valuation, ownership and control, public and private use, exploitation and conservation. P, 1a or Econ. 1a.  
Kelso

205. Farm and Ranch Management (3) II  
Farm management principles and their application to decisions of the farm and ranch family; planning the farm or ranch business for maximum profits; the day-to-day decisions made in adjusting the over-all farm or ranch plan to changes; ways and means of getting the resources needed to carry out sound plans, including problems of becoming established in farming and ranching. P, 1a or Econ. 1a. One 2-day field trip. Fee, $5.  
Moran

208. Farm and Ranch Finance (2) I 1960-61  
Principles of farm finance; procedures in securing credit; and analysis of lending agencies. P, 1a or Econ. 1a. One 1-day field trip. Fee, $2.  
Nelson

209. Farm and Ranch Appraisal (2) I 1959-60  
Value and appraisal of farms and ranches; the valuation procedure factors determining farm and ranch values; appraisals for different purposes; the rural appraisal profession. P, six units in agricultural economics, economics, or business administration. One 1-day field trip. Fee, $2.  
Nelson

210. Agricultural Policy (3) II  
Development of our agricultural policy; various types of programs and the place of such programs in our present-day agricultural economy. P, 1a or Econ. 1a.  
Seltzer

300. Research Methodology in Agricultural Economics (3) II  
Study of the research process in agricultural economics as an efficient means of acquiring reliable knowledge for problem solutions. P, graduate standing.  
Kelso

304. Agricultural Production Economics (3) I  
The application of economic principles to basic problems in agricultural production and resource use. Economic analysis of physical input-output data to aid in decision-making. P, 205 or equivalent.  
Nelson

399. Seminar (1) II  
Kelso

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II  

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II  
Maximum total credit permitted, 8 units.

AGRICULTURAL EDUCATION

Professors Russell W. Cline, Ph.D., Head, Edgar J. Boone, Ph.D. (State Program Leader, Agricultural Extension Service)

Associate Professor John R. Williams, Ph.D.

The department offers programs of study leading to the degrees of Master of Science and Master of Agricultural Education. A total of 30 semester credits including a thesis is required for the Master of Science degree and 32 credits for the Master of Agricultural Education. A thesis is not required for this degree, but the candidate shall complete a research problem related to the major field of study.
The major for the master's degree shall include a minimum of 20 credits in agriculture and agricultural education. Additional supporting course work shall be in business administration, education, psychology, sociology, or other approved subjects appropriate to teaching, extension, and similar educational work.

Research may be conducted in any phase of education related to the broad field of agriculture. Students will work under the direction of staff members engaged in research and service studies in agricultural teaching and extension.

Applicants for admission to graduate study in agricultural education should have the Bachelor of Science degree in agriculture with broad preparation in the areas of animal production, economics, engineering, plants, and soils. Undergraduate study should also include professional courses for teaching agriculture or qualification for agricultural extension work.

In addition to the following, a number of graduate courses are offered by the department during the summer session.

293. College Teaching of Agriculture (2) I Cline
Objectives, the learning process, selection and organization of content, procedures of instruction and evaluation designed for those teaching or preparing to teach adults with special reference to agriculture in junior and senior colleges. P, a course in psychology or educational psychology and 16 units in agriculture.

301. Advanced Agricultural Education (2) I Cline-Williams
Advanced problems in organizing and conducting programs of instruction in agriculture. P, 189.

309. Supervised Farm Practice in Vocational Agriculture (2) II Williams
Understanding, selecting, and planning student farming programs; including budgeting, financing, record keeping, equipment, materials, operative and managerial production practices. Organizing r & d supervising individual and group learning activities for students on the farm. 1R, 3L. P, 189 or CR. Fee, $4.

315. Investigations and Studies in Agricultural Education (2) I Cline
A study of research procedure and a review of the findings of studies. Selecting a problem, planning and completing a study. P, 6 units of graduate study in student's major field including 2 units in agricultural education.

399. Seminar (1-2) II Staff
Study of selected topics and current developments in agricultural education. P, 189.

Course in Education

Principles of Vocational Education (2) II Cline
See Education 209, page 88.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 4) I, II
410. Thesis (2 to 6) I, II Maximum total credit permitted, 6 units.

AGRICULTURAL ENGINEERING

Professors Harold C. Schwalen, M.S., C.E., Head, Richard K. Frevert, Ph.D.
Associate Professor Kenneth R. Frost, M.S.A.E.
Assistant Professors Moody D. Cannon, M.S., David W. Fonken, M.C.E., Frank Wiersma, M.S.

The Department of Agricultural Engineering is primarily a research department, but arrangements may be made for a program leading to a Master of Science degree in Agricultural Engineering by combining work in civil or mechanical engineering to meet the major requirements.
205. Irrigation Practice (4) II  
Frost  
Method of irrigation, conveyance, and measurements of water, water requirements, pumping plants and farm levels. 2R, 6L. P, Physics 5. Fee, $3.

206. Groundwater Supplies (2) II 1959-60  
Schwalen  
The occurrence, sources, movement, and safe yield of ground-water, well drilling and development, pumping equipment. 1R, 3L. P, 205 or CR 215, Geology 51, Physics 5. Fee, $3.

211. Farm Machinery for Engineers (3) II  
Cannon  
Design and construction as well as the selection, economic application, operation, adjustment, care, and repair of all types of agricultural machinery. 2R, 3L. P, junior standing in engineering. Fee, $3.

212. Farm Buildings (3) I  
Wiersma  
Design of farm structures, selection of materials, construction details, arrangement and location. 2R, 3L. P, Civil Engineering 114. Fee, $3.

213. Farm Power for Engineers (3) I  
Frost  
Sources of farm power and its economic application. Theory and development of the internal combustion engine. Design, construction, operation, and adjustment of various types in general use. 2R, 3L. P, Mechanical Engineering 141. Fee, $3.

215. Irrigation Engineering Practices (3) II  
Frost-Schwalen  
Methods of irrigation, design of conveyance, control and distribution structures, plant-water relations, ground-water development and pumping equipment, and irrigation system layout. 2R, 3L. P, Civil Engineering 51, Mechanical Engineering 130. Fee, $3.

220. Hydrology (2) II  
Fonken  
A study of the occurrence and measurement of precipitation and run-off, the relationship between them; flood characteristics; seepage, evaporation and transpiration losses; surface water yield from both small and large areas; and opportunity for ground-water recharge. 2R, P, Civil Engineering 222. Fee, $3.  
(Identical with Civil Engineering 223)

399. Seminar (1) II  
Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 4) I, II
410. Thesis (2 to 4) I, II  
Maximum total credit permitted, 4 units.

AGRONOMY

Professor Dean F. McAlister, Ph.D., Head, Arden D. Day, Ph.D.  
Associate Professors: Keith C. Hamilton, Ph.D., Robert T. Ramage, Ph.D., Neal Wright, Ph.D.  
Assistant Professors Robert E. Briggs, Ph.D., Martin A. Massengale, Ph.D., David D. Rubis, Ph.D.

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The Doctor of Philosophy degree is offered with agronomy as the field of specialization under the Plant Science Program (see page 44).

Agronomic research may be conducted in one of several phases of crop production, such as field crop interrelationships with soil, water, and climatic factors; crop sequence and its effects on production; or crop physiology. Research may be on cotton, industrial crops, forage and pasture plants, cereals or weed control. Special facilities in the Department of Agronomy consist of greenhouse space, experiment farms located in the main agricultural areas of Arizona, and a completely equipped cotton fiber-testing laboratory.

Acceptance for graduate work in agronomy is dependent upon the candidate's having a Bachelor of Science degree in agriculture, including 16 semester hours or more in agronomy or an allied field. Basic courses in the fields of botany, entomology, plant pathology, and soils are prerequisite to graduate study in agronomy.
202. Grain and Cereal Crops (3) I  
A general course in grain crop production and improvement throughout the world, particularly in the United States and Southwest. P, Botany 1, 93 or 203, Entomology 1, Plant Pathology 5. One 1-day field trip. Fee, $5.

203. Cotton and Other Fiber Crops (3) I  
Briggs  
Principles and practices of growing and harvesting cotton and other fiber crops. Emphasis will be on cotton production, fiber technology, and utilization. One 1-day field trip. P, Botany 1, Ag. Chem. 11, Chem. 1b. Fee, $3.

205. Weed Control (3) I  
Hamilton  
Principles and effects of controlling agronomic, horticultural, and range weeds, with emphasis on chemical control methods; weed identification. 2R, 3L. P, Botany 93 or 203. Fee, $4.

207. Crop Ecology and Geography (3) II 1959-60  
McAlister  
A study of environmental factors affecting agronomic crop distribution and geography throughout the world. P, Botany 93 or 203.

399. Seminar (1) I, II  
Staff  
A review of current literature on field crop production and improvement. First semester, for seniors and graduate students; second semester, offered jointly with the Department of Plant Breeding, for graduate students only.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 8) I, II
410. Thesis (2 to 8) I, II
420. Dissertation (1 to 9) I, II

ANIMAL PATHOLOGY

Professors William J. Pistor, D.V.M., Head, Raymond E. Reed, D.V.M.

Assistant Professor Leonard W. Dewhirst, Ph.D.

No advanced degree in animal pathology is offered. The courses listed below may be included in graduate study programs approved by other departments.

203. Parasites of Domestic Animals (2) I 1959-60  
Dewhirst  
The biology, distribution, economic importance, pathogenicity, diagnosis, treatment, and control of parasites of domestic animals with emphasis on the disease-producing capabilities of parasites. P, Zoology 1a.

205. Animal Diseases (3) I  
Pistor  
Animal hygiene and disease prevention, errors in feeding and care of animals. P, Bacteriology 17.

399. Seminar (1) I, II  
Staff  
Offered jointly with the Departments of Animal Science, Dairy Science, and Poultry Science.

ANIMAL SCIENCE

Professors Bruce R. Taylor, Ph.D., Head, Carl B. Roubicek, Ph.D., Ernest B. Stanley, M.S.

Associate Professors O. Floyd Pahnish, Ph.D., William J. Van Arsdell, Ph.D.

Assistant Professor Eugene S. Erwin, Ph.D.

The department is prepared to provide the requisite training and laboratory facilities for the Master of Science degree in animal nutrition and animal breeding.

Acceptance for graduate work will be granted holders of the Bachelor of Science degree from agricultural colleges of acceptable standing, provided that the
The undergraduate program represents the usual college course of four years including subject matter courses in animal science, that the scholarship record is satisfactory, and that the student can be accommodated in the field he wishes to study.

The department cooperates with the Committee on Biochemistry and Nutrition with both course work and research leading to the Doctor of Philosophy degree.

204. Principles of Animal Nutrition (3) I Erwin
Digestion, assimilation, metabolism of feeds by livestock; the chemistry and physiology of minerals, vitamins, and hormones. P, Animal Pathology 116 Chemistry 1b or 140a.

Essential nutritive requirements of livestock and poultry; sources and composition of nutrients; replacement value of feeds in rations; identification of ingredients and the mixing and preparation of feeds. 3R, 3L, 1 quiz. P, 204, Fee, $3. (Identical with Dairy Science 210 and Poultry Science 210.)

213. Animal Breeding (3) II Pahnish
Application of the principles of genetics to animal breeding and selection. P, Botany 132.

215. Physiology of Reproduction and Milk Secretion (4) II Fossland
(Identical with Dairy Science 215)

305. Ruminant Nutrition (3) I Erwin
Implications of recent findings in ruminant nutrition; the physiochemical processes of digestion and absorption; importance and metabolism of rumen microflora; normal metabolism and metabolic disorders; modes of action of feed stimulants. P, 204, 210, Chemistry 1b or 140a.

399. Seminar (1) I, II Staff
Offered jointly with the Departments of Animal Pathology, Dairy Science, and Poultry Science.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units.

ANTHROPOLOGY

Professors Emil W. Haury, Ph.D., Head, Edward P. Dozier, Ph.D., Frederick S. Hulse, Ph.D., Edward H. Spicer, Ph.D., Donald S. Klaiss, Ph.D. (Sociology), Raymond A. Mulligan, Ph.D. (Sociology)

Associate Professors Harry T. Getty, Ph.D., William C. Lawton, Ph.D. (Sociology), Clara Lee Tanner, M.A., Raymond H. Thompson, Ph.D., Richard B. Woodbury, Ph.D., Terah L. Smiley, M.A. (Geochronology)

Assistant Professor I. Roger Yoshino, Ph.D. (Sociology)

Instructors Bryant Bannister, M.A., James M. Mahar, B.A. (Oriental Studies)

Lecturers Robert A. Hackenburg, M.A., William H. Kelly, Ph.D.

The Department of Anthropology offers graduate work in four fields (archaeology, cultural anthropology, linguistics, and physical anthropology) leading to the Master of Arts and Doctor of Philosophy degrees.

The resources of several research facilities are available to qualified graduate students. The Bureau of Ethnic Research is an information and research center at present focusing on modern Indian groups and current Indian affairs. The Laboratory of Physical Anthropology has available material for studies in comparative
primate anatomy, for work on special problems in human biology and genetics, the United States Public Health Service Xrays of 3,000 Indian children, and collections of human skeletal material excavated from archaeological sites.

Qualified students have ready access to the extensive archaeological and ethnological collections in the Arizona State Museum, including the unmatched resources for study in southwestern archaeology which have been transferred to the museum from Gila Pueblo. Field training in archaeological techniques is offered on the graduate level at the University of Arizona Archaeological Field School which is operated jointly by the department and Arizona State Museum at Point of Pines on the San Carlos Indian Reservation, Arizona.

The Laboratory of Tree-Ring Research and the Geochronology Laboratories provide opportunities for climatic and chronological studies of special interest to advanced students in archaeology.

Before the student who transfers to anthropology from another field can be admitted to full graduate standing, he must meet the departmental requirements for the bachelor's degree in anthropology (or their equivalent): six units each in general anthropology (la-1b), cultural anthropology (25a-25b), archaeology (35a-35b), physical anthropology (140a-140b), and linguistics (150a-150b). The major may be taken in any one of the four fields of anthropology. The supporting minor may be taken within the department, subject to the approval of the Graduate Council.

200. Primitive Art and the Museum (2) I 1959-60 Pleasants An illustrated survey of selected significant art styles in major world regions of prehistoric and primitive art development. Emphasis will be on curatorial problems of identification, authenticity; and connoisseurship.

201a-201b. Introduction to Indic Civilizations (3-3) Yr. Mahar An examination of social and political institutions, arts, and philosophy of traditional Indian society from prehistoric times to the present. Special attention is given to Hindu religion and its interrelations with the social order.

203. Cultural Change (3) II 1959-60 Spicer Internal change in cultures; innovation, integration; contact change; diffusion, acculturation, social-cultural fusion; cultural evolution. P, 25a-25b.

205. Language in Culture (3) II 1959-60 Staff A survey of the literature pertaining to the nature of the interrelationships between language and other cultural phenomena. P, 150a-150b.

210. Introduction to Southeast Asia (3) I Hackenberg Discussion of the sequence of cultures of the region, formation of native kingdoms, and the colonial period. Analysis of revolutionary movements and contemporary socio-economic problems of the new nations of the region.

211. Contemporary Southeast Asia (3) II Hackenberg The background of the twentieth-century socio-economic and political life in Southeast Asia. Cultural features of urban and rural life today will be discussed and compared throughout the area. P, 12 units in social science.

212. Peoples of Mexico (3) II 1960-61 Spicer Cultural background and present-day economic, social and religious life of Indian and mestizo groups in rural regions; processes of acculturation and current trend in cultural development. P, 1a-1b.

214a-214b. Scientific Illustration (2-4, 2-4) Yr. Sayner (Identical with Zoology 218a-218b)

215R. Archaeology of the Southwest (3) I Thompson Development of culture in the prehistoric Southwest with emphasis on chronology, cultural persistence and change, and culture classification. Field trip. P, 35a or equivalent. Fee, $8.

217. Phonetics (3) I
Staff
Principles of phonetic description; drill in transcribing speech sounds in phonetic notation, with data drawn primarily from American Indian languages. P, 150a-150b.

218. Phonemics (3) I
Staff
Techniques of discovering and describing the minimal significant units of the sound systems of languages; practice in application of these techniques to language data. P, 150a-150b.

219. Morphemics (3) II
Staff
Techniques of discovering and describing the minimal significant units of the grammatical systems of languages; practice in application of these techniques to language data. P, 150a-150b.

220. Minority Peoples of the United States (3) I
Spicer
History, present status, and problems of racial and cultural minorities in the United States; American Indian, Negro, Oriental, Spanish-American, and Jewish groups. P, 1a-1b, or 6 units of sociology.

221. Sociology of Minority Relations (3) II
(Yield with Sociology 222)
Yoshino

235a-235b. Southwestern Indian Arts (3-3) Yr.
235a. Survey of prehistoric utilitarian and aesthetic arts.
235b. Survey of the art of the modern Indians of the Southwest. P, 1b or 6 units in art. 235a is not prerequisite to 235b.

240. Primatology (3) II 1959-60
Hulse
A comparative study of primate anatomy, physiology, and behavior, including social behavior. Analysis of similarities and distinctions between human and non-human primates. P, 140a-140b or junior standing in zoology.

255. Quantitative Studies in Cultural Anthropology (3) I
Hackenberg
Review of the quantitative studies which have been made by cultural anthropologists. Discussion of the types of problems, populations, and conceptual approaches which involve or require the use of quantitative assumptions and inferences.

270. Modern Communities (3) II
Getty
Comparative analysis of contemporary communities in Asia, Latin America and the United States. P, 25a-25b or 6 units in sociology.

278a-278b. Archaeology of the Old World (3-3) 1960-61
Tanner
An intensive survey of major archaeological sites of Europe, Asia, and Africa, with emphasis on problems of dating, cultural origins, migrations, and centers of development. P, 35a-35b.

279. Culture and the Individual (3) II
Hackenberg
A survey of the field of culture and personality and the processes through which the individual acquires culture. P, 276 or equivalent. (Identical with Sociology 279)

280. Archaeology of North America (2) I 1960-61
Thompson
Peopling of the New World; spread of agricultural economy from Mesoamerica to other parts of the continent; development of specialized ways of life beyond the northern limit of maize agriculture. P, 35a or equivalent.

282. Archaeology of South America (2) II 1960-61
Thompson
Development of the Andean civilizations and their influence on the prehistoric cultures in the rest of South America. P, 35a or equivalent.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Year</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>283</td>
<td>Economic Life of Primitive People (3) I 1959-60</td>
<td>Getty</td>
<td></td>
<td>A consideration of pertinent concepts in the fields of anthropology and economics, including the major categories of production, exchange, distribution, consumption, property, economic surplus, inheritance, and types of economic structure. P, 25a-25b or 12 units in economics. (Identical with Economics 283)</td>
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<tr>
<td>284</td>
<td>Regional Sociology (3) I</td>
<td>Klaiss</td>
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<tr>
<td>286</td>
<td>Culture Patterns of Japan (2) I 1959-60</td>
<td>Hulse</td>
<td></td>
<td>An investigation into the cultural foundations and value systems of the Japanese people.</td>
</tr>
<tr>
<td>295</td>
<td>Dendrochronology (3) I</td>
<td>Smiley</td>
<td>1959-60</td>
<td></td>
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<tr>
<td>298</td>
<td>Seminar on Latin America (2) I, II</td>
<td>Spicer-Staff</td>
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<tr>
<td>302a-302b</td>
<td>Theory in Cultural Anthropology (3-3) Yr.</td>
<td>Spicer</td>
<td></td>
<td>Historical development of concept and theory; intensive analysis of selected areas of theory. P, 276 or equivalent.</td>
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<tr>
<td>307a-307b</td>
<td>Methods in Archaeology (2-2) Yr. 1960-61</td>
<td>Haury</td>
<td></td>
<td>Field and laboratory techniques; problems related to project formulation and report writing. P, 215R-215L.</td>
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<tr>
<td>311a-311b</td>
<td>Tree-Ring Dating for Archaeologists (3-3) Yr.</td>
<td>Bannister</td>
<td></td>
<td>Theoretical approach to the development and application of tree-ring dating in southwestern archaeology. 2R, 3L. Fee, $5.</td>
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<tr>
<td>316</td>
<td>Ancient Civilizations of Mesoamerica (3) I 1959-60</td>
<td>Thompson</td>
<td></td>
<td>Comparative study of cultural development in Mesoamerica with emphasis on the agricultural beginnings, settlement pattern and urbanization, hieroglyphic writing, and calendarical systems. Ability to read Spanish is desirable.</td>
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<tr>
<td>322</td>
<td>Applications of Anthropology (3) I 1960-61</td>
<td>Kelly</td>
<td></td>
<td>Methods and results in the application of cultural anthropology in colonial administration, industrial relations, Indian affairs, and resettlement programs. P, 203.</td>
</tr>
<tr>
<td>330a-330b</td>
<td>Ethnology of the Southwest (3-3) Yr.</td>
<td>Getty</td>
<td></td>
<td>Culture, history, economic and social institutions, religion, and mythology of the living Indians of the Southwest. P, 25a-25b. Fee, for 330b, $8. 330a is not prerequisite to 330b.</td>
</tr>
<tr>
<td>345</td>
<td>Human Origins (3) II 1960-61</td>
<td>Hulse</td>
<td></td>
<td>Physiological bases and trends of evolution; detailed study of the fossil evidence for the evolution of Homo sapiens from a primitive generalized primate ancestor; evaluation of the theories pertaining to the line of ascent of mankind. P, 140a-140b.</td>
</tr>
<tr>
<td>350a-350b</td>
<td>American Indian Languages (2-2) Yr. 1960-61</td>
<td>Staff</td>
<td></td>
<td>Distribution of American Indian languages; morphology; recording; and linguistic structure of an American Indian language. P, 150a-150b.</td>
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<tr>
<td>360</td>
<td>Readings in World Ethnology (3) I</td>
<td>Getty</td>
<td></td>
<td>Directed reading in the ethnology of Africa, Asia, or Oceania. May be repeated for credit without duplication of work.</td>
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<tr>
<td>399</td>
<td>Seminar (3) I, II</td>
<td>Staff</td>
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<td>Problems in southwestern anthropology. May be offered in sections dealing with different topics. P, 215L or 330a-330b. Fee, $5, when field trips are involved.</td>
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</tbody>
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**INDIVIDUAL STUDIES**

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<thead>
<tr>
<th>Course Code</th>
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<th>Instructor</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>299</td>
<td>Special Problems (1 to 5) I, II</td>
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<td>400</td>
<td>Research (1 to 4) I, II</td>
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<td>410</td>
<td>Thesis (1 to 4) I, II</td>
<td></td>
<td>Maximum total credit permitted, 4 units.</td>
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<tr>
<td>420</td>
<td>Dissertation (1 to 9) I, II</td>
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ART

Professors Andreas S. Andersen, Head, James P. Scott
Associate Professors Robert W. Bretall, Ph.D. (Philosophy), Gordon Heck, M.Arch. (Architecture), Robert M. Quinn, Ph.D., Mark Voris, B.F.A.
Assistant Professors Douglas G. Denniston, M.A., Maurice K. Grossman, M.A., James G. Souden, M.A., M.S.

Robert M. Church, A.B., Director, University Art Gallery.

Graduate work in art is open to students who have completed an undergraduate major in art in the University or a comparable curriculum at other institutions. Special facilities for graduate work include the T. E. Hanley Fine Art Collection of 34,000 volumes; the Samuel H. Kress Collection of 14th- to 19th-century European art; the Charles Leonard Pfeiffer Collection of American Art, consisting of more than 100 contemporary American paintings; the Edward Joseph Gallagher III Memorial Collection of contemporary American painting, European, Latin American, and Oriental objects of art; the Mr. and Mrs. N. R. Feldman Collection of contemporary European art; and miscellaneous collections, including the University Print Collection of notable examples of various graphic arts. The University of Arizona Art Gallery schedules exhibitions from these collections and, from time to time, other exhibitions of general and special interest.

The department offers courses at the graduate level leading to the degree of Master of Fine Arts with concentrations in painting, drawing, sculpture, the print processes, ceramics, crafts, and commercial design; and the degree of Master of Arts with majors in the history of art and in art education.

See page 38 for Master of Education degree major or minor in this department.

204. Medieval Art (3) I Quinn
The architecture, sculpture, and pictorial arts in western Europe from the beginning of the Christian era through the Gothic. P, 6 units of history or art history.

205a-205b. Renaissance Painting (3-3) Yr. 1959-60 Quinn
205a: The Italian schools of painting from the thirteenth through the sixteenth centuries.
205b: Painting of the fourteenth, fifteenth, and sixteenth centuries in Flanders, France, and Germany. P, 6 units of history or art history. 205a is not prerequisite to 205b.

207. Seventeenth- and Eighteenth-Century Painting (3) I 1959-60 Quinn
Painting in Italy, France and the Low Countries, and Spain in the Baroque and subsequent periods. P, 6 units of history or art history.

210a-210b. Nineteenth- and Twentieth-Century Painting (3-3) Yr. Scott
210a: Analytical and appreciative study of the nineteenth-century movements and schools in France. 210b: Similar study of twentieth-century movements and schools in France and Germany, with their influences upon the United States and Mexico. P, 6 units of history or art history.

213. American Art (3) I 1960-61 Quinn
Survey of the fine and industrial arts of North America, Mexico, South America; influences of aboriginal and imported art tendencies on modern art and the development of American schools. P, 6 units of history or art history.

215. Far Eastern Art (3) I 1960-61 Quinn
Survey of the fine and decorative arts of India, China, and Japan; their influences on each other and on the arts of the West. P, 6 units of history or art history.

216. Islamic Art (3) II 1960-61 Quinn
Survey of the art and architecture of the Near and Middle East. P, 6 units of history or art history.
217. History of Architecture and Sculpture (3) II
   The development of architecture and sculpture in Europe from the beginning of the
   Renaissance to the end of the nineteenth century. P, 6 units of history or art history.

228. Principles of Esthetics (3) I
   (Identical with Philosophy 228)

235a-235b. Southwestern Indian Arts (3-3) Yr.
   (Identical with Anthropology 235a-235b)

240a-240b. Crafts (2-2) Yr.
   A practical acquaintance with the design and technical essentials of the various
   craft media.
   240a: Leather, weaving, silk screen.
   240b: Metal (including silver), jewelry, enamel on metal. 6L. P, 50b. Fee, $8 each
   semester.

242a,b,c,d. Ceramics (2) I, II
   An introduction to ceramic materials, construction, design, glazing, and firing.
   Laboratory experience in building pottery by hand and potter’s wheel. 6L. P, 50b.
   Fee, $8.

243a-243b. Sculpture I (2-2) Yr.
   Study of plastic form; exploration of various techniques including modeling,
   casting, carving, and metal construction. 6L. P, 50b. Fee, $10 each semester.

244a-244b. Sculpture II (2-2) Yr.
   Advanced problems in sculpture. 6L. P, 243b. Fee, $10 each semester.

245a,b,c,d. Figure Drawing II (2) I, II
   Study of the human figure from the model and from the work of the masters;
   emphasis on anatomical sequence and composition. 6L. P, 45b. Fee, $10 each semester.

250a,b,c,d. Water Color Painting, (2) I, II
   Study of the materials and techniques of water-color painting; the theoretical
   considerations of the medium. Demonstration and critique. 2R. P, 50b or Architec-
   ture 24b.

252a-252b. Nineteenth- and Twentieth-Century Architectural
   History (3-3) Yr.
   (Identical with Architecture 252a-252b)

255a,b,c,d. Painting II (2) I, II
   Study of materials and composition in relation to the painter’s problems. Choice
   of exploration and specialization in water color, gouache, tempera, casein, encaustic,
   mixed techniques, and mural painting. 6L. P, 6b. Fee, $3 each semester.

260. The Intaglio Print (2) I
   Practice and exploration in the techniques of the intaglio plate: etching, engraving,
   aquatint, drypoint, and mezzotint. 1R, 4L. P, 50b. Fee, $5.

261. The Relief and Serigraphic Print (2) I
   The relief processes: linoleum block, woodcut, and wood engraving; silkscreen and
   stencil techniques. 1R, 4L. P, 50b. Fee, $5.

262. The Lithographic Print (2) II
   Methods and materials used in stone and metal-plate lithography. 1R, 4L. P, 50b.
   Fee, $5.

264. Graphic Studio (2) I, II
   Advanced study in any of the graphic media. May be repeated for credit. 6L. P, 260,
   261, or 262, Fee, $5.

265a-265b. Commercial Design I (2-2) Yr.
   Advanced studies in visual design related to commercial applications with emphasis
   upon the appropriate tools and techniques of the craft. Problems in layout, applied
   lettering, typographic usages, methods of graphic reproduction. 6L. P, 50b, 60b.
   Fee, $2 each semester.

266a-266b. Commercial Design II (2-2) Yr.
   Continued advanced design studies with commercial application. Expanded prob-
   lems in techniques, type selection, and general production. Emphasis upon contempo-
   rary design and psychology of visualization in the advertising and sales field. 6L.
   P, 265b. Fee, $2 each semester.
267a-267b. Illustration (2-2) Yr. Voris
Technical and stylistic studies in the fields of product, advertising, editorial, and fiction illustration. Exploration in factual and interpretive visualization for mood and idea transmission via the printed surface. Use of the costumed model. 6L. P. 50b, 55b. Fee, $4 each semester.

280a,b,c,d. Painting III (2 to 4) I, II Andersen
Advanced problems in painting. 6L to 12L. P, 55b or 255b. Fee, $10 each semester.

298. Seminar on Latin America (2) I, II Quinn-Staff
(Identical with Spanish 298)

330. Seminar in Art Museum Techniques (2-6) I, II Church
May be repeated for credit.

399. Seminar in Art History (2 to 4) II Quinn

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

340. Problems in Art (2 to 4) I, II
May be repeated for credit.

350. Graduate Studio (8-10) I, II
May be repeated for credit.

355. Mural Decoration (6-10) I, II
May be repeated for credit.

400. Research (1 to 4) I, II

410. Thesis (3 to 6) I, II Maximum total credit permitted, 6 units.

ASTRONOMY

Professors Edwin F. Carpenter, Ph.D., Head, Andrew E. Douglass, D.Sc., John C. Duncan, Ph.D., Assistant Professor Walter S. Fitch, Ph.D.

Largely through the generosity of several donors, the Steward Observatory offers exceptional opportunities for graduate instruction and research in astronomy. In addition to equipment for undergraduate instruction, the principal instruments of the Observatory are: 1. The 36-inch Steward Reflecting Telescope, which has three focal arrangements, Newtonian, Cassegrainian, and coudé, respectively of 15, 45, and 110 feet focal length and which is equipped for direct photography, for photoelectric photometry, and for low-dispersion spectroscopy of very faint objects. 2. The 12½-inch Calver Reflecting Telescope, which is used for instruction. 3. The 7-inch Bailey Photographic Refractor, which is primarily used for automatically timing eclipsing stars and for seeking supernovae. 4. A recording microphotometer and other apparatus which are used for photographic photometry.

In view of the exceptional telescopic equipment, the work of the department leans in the direction of observational rather than computational astronomy. It is therefore important that prospective graduate students should have an adequate background not only in mathematics but especially in physics. Specialized courses in the fields of optics, thermodynamics, electricity, and atomic physics are desirable. If these conditions are well met, then the undergraduate major may have been taken either in physics, or mathematics, or astronomy. Students preparing for astronomical research should acquire a reading knowledge of two foreign languages as early as practicable, before entering graduate school if this is at all possible. The languages should be chosen from German, Russian, French.

The graduate program may lead to the degree of Master of Science. Appropriate graduate courses in mathematics and physics may be counted towards the
graduate major in astronomy. Only for an exceptionally heavy observational pro-
gram will more than four units be allowed for the thesis.

Note: Not all of the following courses are offered annually. Interested students
should consult the department as early as possible.

202. Method of Least Squares and the Theory of Interpolation (3) I Carpenter
   Errors of observation and their propagation; adjustment of observations by the
   method of least squares; the theory of interpolation and its application to the use
   and construction of extensive tables. P, Math. 79b. (See note above.)

203. Spherical Astronomy (3) II Carpenter
   The mathematical theory of precession, nutation, and related subjects; reduction of
   star places; measurement of astronomical photographs. P, Math. 79b. (See note above.)

205. Introduction to Celestial Mechanics (2) I Fitch

249. The Determination of Orbits (3) II Duncan
   The problem of two bodies; the determination of the orbits of planets and comets,

260. Astronomical Spectroscopy (3) II 1960-61 Staff
   Astronomical spectrographs; measurement and reduction of spectrograms; inter-
   pretation. P, 1b or 100b, Math. 79b, Physics 220.

304a-304b. Astrophysics and Stellar Astronomy (3-3) Yr. Staff
   The instrumentation for astrophysics: astronomical photometry; stellar masses and
   motions; the interstellar medium; clusters and nebulae; interpretation of spectra.
   P, 1a-1b or 100a-100b, Math. 79b, Physics 220. (See note above.)

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (1 to 8) I, II
410. Thesis (1 to 8) I, II Maximum total credit permitted, 8 units.

BACTERIOLOGY AND MEDICAL TECHNOLOGY

Professors Kenneth F. Wertman, Ph.D., Head, Hugh H. Smith, M.D., Ralph W.
G. Wyckoff, Ph.D.

Associate Professor Gerd T. Schloss, M.D.

Assistant Professors Adelaide E. Evenson, Ph.D., Irving Yall, Ph.D.

The Department of Bacteriology and Medical Technology offers graduate
work leading to the degree of Master of Science and Doctor of Philosophy. To be
eligible for graduate study, a student should have completed sufficient basic
undergraduate courses in bacteriology and chemistry to enable him to do
advanced work in these sciences.

The requirements for the degree of Master of Science follows the general
requirements of the Graduate College. Prior to admission to candidacy for the
degree a preliminary comprehensive examination covering the basic sciences is
required. This examination should be taken during the first semester of graduate
study. A thesis reporting the research accomplished must be approved and ac-
cepted by the candidate's examining committee. Each candidate must pass a final
oral examination which shall be in part a defense of the thesis, but in the main
a general examination on basic science matter, particularly microbiology and
chemistry.

The requirements for the Doctor of Philosophy degree follow those set by
the Graduate College. In general, the student will be expected to take sufficient
course work in the various fields of bacteriology to insure a broad knowledge of
his profession. In addition, he is expected to develop high proficiency in the fields most closely related to his research problem. It is recommended that the student majoring in bacteriology select two minors, one in chemistry and the other from any allied scientific field.

The department has excellent facilities (including two Philips electron microscopes, radioisotope equipment, walk-in incubators and cold rooms, C.B.R. units for safe handling of highly infectious materials, etc.) to pursue its research interests, which at the present time are concerned with the interrelationships between viral and rickettsial agents and their host cells, the effects of nutritional deficiencies on susceptibility of animal hosts to parasitism by bacterial and viral agents, microbial metabolism, and fungi of medical significance, among other problems. Research assistantships and teaching assistantships are available to qualified students.

219a-219b. Infection and Immunity (4) Yr.
   Wertman
   A study of microorganisms that are pathogenic for man and animals. The isolation and identification of these organisms and the mechanisms of the antigen-antibody reactions. 2R, 6L. P, 8 units of bacteriology. Fee, $10.

227. Yeasts and Molds (4) I
   Evenson
   Methods of isolation, cultivation, and identification of yeasts and molds with the emphasis on the organisms that are of industrial importance. 2R, 6L. P, 8 units of bacteriology. Fee, $10.

239. Higher Bacteria (4) I
   Evenson
   The morphological and cultural characteristics of the higher bacteria. 2R, 6L. P, 16 units of bacteriology. Fee, $10.

249. Medical Mycology (4) II
   Evenson
   The isolation and identification of the yeasts and molds that produce disease in man. 2R, 6L. P, Bacteriology 219a, 227; CR 219b. Fee, $10.

285. Identification of Economic Fungi (3) I
   Streets
   (Identical with Plant Pathology 285)

309. Control of Infectious Disease (3) II
   Smith
   The scientific application of our knowledge for the promotion of health, prevention of disease, and prolongation of life. Study and control of epidemic diseases will be emphasized. 3R. P, 219b.

317a-317b. Bacterial Physiology (4-4) Yr.
   Yall
   A study of the physiological properties of bacteria including metabolic patterns and nutritional requirements. 2R, 6L. P, 16 units of bacteriology and Chemistry 260a. Fee, $10.

319a-319b. General Pathology (3-3) Yr.
   Schloss
   The reactions of the tissues of man and experimental animals to the invasion by microorganisms will be studied. This includes changes due to inflammation, degeneration, and neoplasia. Gross and microscopic examinations. P, 219b. Fee, $7.

320. Virus Diseases of Plants (4) II
   Keener
   (Identical with Plant Pathology 320)

327. Animal Virology (2) I
   Smith

328. Animal Virology—Laboratory Studies (2) I
   Smith
   Tissue culture methods, animal inoculation procedures, and serological techniques employed in the study of virus diseases will be presented. P, Bacteriology 219b, P or CR, 327. Fee, $15.

337. Rickettsiae (2) II 1959-60
   Wertman

347. Systematic Bacteriology (4) II
   Evenson
   Principles of taxonomy and nomenclature and their applications to the problem of bacterial classification. 2R, 6L. P, 20 units of Bacteriology. Fee, $10.

357. Bacterial Cytology and Genetics (2) II 1960-61
   Staff
   The structure and composition of the bacterial cell. Bacterial genetics. P, 16 units of bacteriology.
367. Sterilization and Disinfection (2) I 1960-61 Yall
The kinetics of sterilization and disinfection. P, 16 units of bacteriology.

377. Microbial Systems: Enzymes and Metabolism (4) I 1959-60 Yall
Studies of the metabolic pathways of selected bacteria, rickettsiae, and viruses. The use of radioactive techniques and cell-free enzyme isolation and purification techniques will be emphasized. 2R, 6L. P, Chemistry 260, Physics 150. Fee, $10.

The theory and practice of the electron microscope, methods of specimen preparation, interpretation of micrographs, and electron optical techniques other than electron microscopy. 2R, 6L. Fee, $15.

399. Seminar (1) I, II Staff
Required of graduate students in bacteriology, open to seniors.

INDIVIDUAL STUDIES

299. Special Problems (2 to 4) I, II
400. Research (2 to 4) I, II
410. Thesis (2 to 4) I, II Maximum total credit permitted, 8 units
420. Dissertation (1 to 9) I, II

BOTANY
Professor Walter S. Phillips, Ph.D., Head
Associate Professors Robert W. Hoshaw, Ph.D., Edwin B. Kurtz, Ph.D., Charles T. Mason, Ph.D.
Assistant Professors Robert M. Harris, Ph.D., Raymond M. Turner, Ph.D.

Graduate work for the Master of Science and Doctor of Philosophy degrees is offered in anatomy, cytology, ecology, genetics, morphology, plant physiology and biochemistry, and taxonomy. The Doctor of Philosophy degree is offered with botany as a field of specialization under the Plant Science program (see page 44).

Candidates may select their own research problems or join groups now active in research on mineral nutrition, cytotaxonomy, metabolism, pollen analysis and geochronology, chemical genetics, and taxonomy and anatomy of southwestern plants.

Research facilities and equipment include radioisotope instruments, Warburg respirometer, Avena equipment, hydrophonic apparatus, high-speed centrifuges, colorimeters and spectrophotometers, radiation equipment, greenhouse, herbarium of 200,000 sheets, darkroom, and research laboratories.

A student in any field of botany is required to present for the degree a well-rounded program of study. Course work in various departments other than botany is desirable. Work for the minor may be chosen from the following departments: Agricultural Biochemistry and Nutrition, Agricultural Chemistry and Soils, Agricultural Economics, Agronomy, Animal Science, Bacteriology and Medical Technology, Chemistry, Geochronology, Entomology, Geology, Horticulture, Plant Breeding, Plant Pathology, Watershed Management, and Zoology (including Wildlife Management).

Teaching and research assistanships are available for qualified students.

See page 38 for Master of Education degree major or minor in this department.

202. Plant Anatomy (4) I Phillips
Origin, development, and maturation of the structures of the vascular plants. 2R, 6L. P, 1, Fee, $5.
203. Elementary Plant Physiology (4) II
   Kurtz
   The principles of the nutrition, metabolism, growth, and development of higher
   plants. 3R, 3L. P, 1, Chemistry 140a. Fee, $5.

204. Systematic Botany (4) II
   Mason
   A study of the orders and families of the Spermatophytes according to their
   evolutionary relationships; systems of classification; nomenclature; laboratory and field
   work; collection and identification of local flora. 2R, 6L. P, 1. Fee, $5.

212. Algae (3) I
   Hoshaw
   A general survey of the algae, including classification, structure, physiology, life
   histories, and economic significance. 2R, 3L. P, 2. Fee, $5.

213. Plant-Water Relationships (3) II
   Hoshaw
   A study of the role of water in the physiology of higher plants with special emphasis

218a-218b. Scientific Illustration (2 to 4-2 to 4) Yr.
   Sayner
   (Identical with Zoology 218a-218b)

222. Physiological Genetics (3) II 1959-60
   Harris
   The study of the development and metabolism of organisms in relation to their
   genotyope. Laboratory experiments will utilize both plants and animals. 2R, 3L. P, 132,
   Chemistry 140a-140b or equivalent. Fee, $5.

242. Methods in Plant Histology (4) II
   Phillips
   Principles and methods of killing, fixing, imbedding, sectioning, staining, mounting,

266. Plant Geography (2) I
   Turner
   Theories and principles concerning the ranges of naturally occurring plant taxa
   and communities, both past and present. P, senior standing in a field of biology.

303. Advanced Plant Physiology (3) I
   Kurtz
   A study of the biochemistry of plant nutrition, metabolism, and growth and its
   application to current problems, such as growth regulators and effect of climate;
   methods in plant physiology. 3R. P, 203; Chemistry 140a, b. Fee, $5.

313. Advanced Plant Physiology Laboratory (2) I
   Kurtz
   Current techniques for qualitative and quantitative studies of physiological processes.
   6L. P, 303 or CR. Fee, $7.

324. Advanced Systematic Botany (4) I
   Mason
   A study of taxonomic ideas and techniques with special emphasis on their applica-
   tion to the gross, composite, and legume families; collection and identification
   of Arizona representatives of these families. 2R, 6L. P, 1, 204. Fee, $5.

332. Cytogenetics (3) II 1960-61
   Harris
   The study of cell structure including the cytoplasmic and nuclear constituents.
   Laboratory experiments demonstrate the role of chromosomes in the differentiation
   and development of organisms. 2R, 3L. P, 1 or Zoology 1a, Botany 132, or Zoology
   272. Fee, $5.

399. Seminar (1) I, II
   Staff
   Literature review and discussions concerning current problems in plant science.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 8) I, II
410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units
420. Dissertation (1 to 9) I, II

Related courses which may be taken for credit in Botany:

Geochronology 295. Dendrochronology (3) I 1959-60
   Smiley
Geochronology 296. Tree Growth and Environment (3) II 1959-60 Staff
Geochronology 300. Methods in Geochronology (3) I Smiley-Staff
Geochronology 301. Laboratory Methods in Geochronology (2) II Smiley-Staff
Geochronology 312. Techniques of Dendrochronology Research
   (3) II, 1960-61
   Staff
Geochronology 375a-375b. Palynology (3-3) Yr.
   Martin
BUSINESS ADMINISTRATION

Professors Shaw Livermore, Ph.D., Acting Head, Elmer J. Brown, Ph.D., Harold J. Hoflich, Ph.D., Glen W. Strickler, LL.B.


Assistant Professors Melvin E. Hecht, M.A., Jefferson M. Hooper, M.A., John W. Leonard, Ph.D.

Instructor Hollis K. Martin, LL.B.

Lecturer Robert C. Parnell, LL.B.

The Department of Business Administration offers graduate work leading to the Master of Science degree and to the Master of Business Administration degree.

In addition to the facilities of this department and of the University Library, graduate students in business administration have access to the research facilities and reference materials of the Bureau of Business and Public Research in the College of Business and Public Administration. The Bureau's research interests lie chiefly in the various aspects of the Arizona economy, and the Bureau endeavors to promote research projects of direct concern to business and community groups and public administrators in this state. Graduate students choosing fields of research appropriate to the Bureau's program may be permitted to do their research work under the direction of Bureau staff members, and their findings may be considered for Bureau publication.

The requirements for the degree of Master of Science with a major in business administration follow the general requirements of the graduate college. The prerequisite for admission for this degree is graduation from an approved college or university with a major in business administration or in business administration and economics.

The Master of Science degree affords an opportunity for specialization to those students who have secured undergraduate training in the general field of business administration. Opportunities are given for specialization in finance, geography, insurance, personnel, production management, and real estate. Each candidate for the degree is required to present an acceptable thesis of four units on some phase of his major concentration.

The degree of Master of Business Administration involves a two-year program intended primarily for students whose undergraduate training has been in other fields. A student with an undergraduate degree from an accredited institution, regardless of his major field, whose grades and letters of reference show promise of ability to handle graduate work may be admitted to candidacy for this degree. For an explanation of requirements see page 38.

201. Personnel Management (3) I

Leonard

Policies and practices in personnel management. Provides a point of view together with principles and techniques applicable to personnel problems. Problems arising in employment relationships and workable solutions. P, Econ. 1b or 2b.

202. Advanced Personnel Management (3) II

Leonard

Evaluation of procedures and techniques in the major functions of personnel management. Critical examination of the assumptions basic to such procedures and techniques. P, 201.

203. Wage and Salary Administration (3) I

Leonard

Policies and procedures effective in administration of wages and salaries, wage levels, wage structures, individual wage determination, methods of wage payment, fringe benefits, control of wages and salaries. P, 201.
204. Collective Bargaining (3) II  

210a-210b. Area Surveys (2-2) Yr.  
The physical, economic, political, and cultural aspects of the geography of (a) the Far East (during the first semester) and (b) the Pacific area (during the second semester).

211. Geography of Mexico and Caribbean America (3) I  
The natural regions and economic, political, and cultural aspects of the geography of Mexico, Central America, the West Indies, and portions of Venezuela and Colombia.

212. Geography of South America (3) II  
The physical, economic, political, and cultural geography of the natural regions and countries of South America.

213. Geography of the United States and Canada (3) I  
The distribution by geographic regions of the resources of land and minerals. The relation of these to man and his economic activities. Contrasts in regional landscapes.

214. Europe West of Russia (3) II 1960-61  
Distinguishing features of Europe as a continent. Origin and nature of human and natural characteristics of each country. Geographic basis for European unification and of problems in selected countries.

215. Geography of Manufacturing (3) I  

216. Political Geography (3) I  
The kind and degree of political control over territory and its relationship to distributional patterns of human and natural geographic elements. Primary consideration given national sovereign states, including analysis of geographic aspects of national power.

217a,b,c,d. Arid Lands of the World (2) I, II 1960-61  
Wilson-Hecht  
An investigation by regions of the natural environment peculiar to arid lands and its meaning for human use. (a) Arizona and environs; (b) The Middle East; (c) Africa; (d) Other areas.

218. World Population and Resources (3) I  
Wilson  
Estimates of present and potential world populations; what these mean in resource needs; possibilities for meeting these needs. Includes distribution of most important natural resources and methods of their conservation. Three field trips. Fee, $3.

219. Maps and Map Making (3) I 1960-61  
Staff  
Maps and their uses; projections; tools and techniques; symbols; problems of design and reproduction. 2R, 2L. Fee, $5.

220a-220b. Business Law (3-3) Yr.  
Parnell-Denton-Martín  
220a: Introduction to sources of commercial law, with emphasis on contracts, property rights, and remedies. 220b: Negotiable instruments, credit instruments, and sales; laws of the business unit, agency, partnerships, and corporations. P, Accmg. 1b, Economics 1b or 2b. Not open to students who have completed 6 or more units of law. 220a and 220b are offered both semesters

225. Industrial Traffic Management (3) II  
(George with Econ. 225)

241. Business Finance (3) I, II  
Strickler-Kirk-Hooper  
Financial problems involved in the organization and conduct of a business. P, Accmg. 1b, Econ, 1b or 2b.

242. Investments (3) II  
Strickler  

250. Life Insurance (3) I  
Roos  
Nature and functions of life insurance with particular attention to policy forms and provisions, uses, the mathematics of life insurance (rates, reserves, dividends), legal aspects, and company organization. P, 151.
251. Advanced Life Insurance (3) II
Roos
Application of life insurance to business needs, with reference to the funding of a buy-and-sell agreement in a proprietorship, partnership, or corporation. An introduction to the basic principles of estate planning, with reference to life insurance. P, 250.

254. Group Insurance and Pensions (2) I 1959-60
Roos
Business, economic, and social background of group insurance; analysis of the operation and uses of group life insurance; group accident and health insurance; and group hospital, surgical, and medical expense insurance. An analysis of the case for pensions; the growth of pension plans; provisions and costs of pensions; types of pension plans; group annuities; and a survey of existing plans. P, 250.

255. Statistical Methods in Economics and Business (4) I, II
Staff
Introduction to methods of collection, presentation, analysis, and interpretation of business and economic data, including simple correlation and sampling. 3R, 3L. P, Math 11, 20, or 69a. Fee, $1. (In 1960, B.A. 255 will be replaced by B.A. 155.)

257. Property Insurance (3) I
Roos
Designed for those students of insurance who desire to concentrate their study of insurance in the property field. P, 151.

258. Casualty Insurance (3) II
Roos
Employers' liability and workmen's compensation, automobile, public liability, power plant, theft, and other forms not covered in property insurance. P, 257.

270. Data Processing and Reduction (3) I, II
Staff
(Identical with Numerical Analysis 270)

271. Advanced Data Processing and Reduction (3) II 1960-61
Staff
(Identical with Numerical Analysis 271)

272. Principles of Management (3) I, II
Staff
Analysis of underlying principles of sound organization and management in business enterprises. P, Acctg. 1b, Econ. 1b or 2b.

273a-273b. Production Management (3-3) Yr.
Gill
Development of American industries; philosophy of F. W. Taylor and other management pioneers; practical application of scientific management to managerial problems; nature and purpose of the production cycle; simplification and diversification of the product line; purchasing; material control; budgetary control and industrial safety. P, 272 (273a is not prerequisite to 273b).

274. Work Simplification and Motion Study (3) II
Gill
Principles and techniques of work simplification and motion economy; work simplification programs; methods of increasing productivity of employees; flow process charts and flow diagrams; fatigue in business and industry; the use of micromotion and time-recording equipment. P, 272.

279. Urban Planning and Development (3) II
Wilson

281. Real Estate Law (3) I
Denton
The principal areas of the law affecting real estate. P, Acctg. 1b; B.A. 80 or 81; B.A. 220b or CR; Econ. 1b or 2b.

282. Real Estate Appraisals (3) II
Denton
The factors, general and specific, affecting the value of real property, including an exposition of the various techniques in appraising and in the preparation of an exposition of the various techniques in appraising and in the preparation of an appraisal report. P, Acctg. 1b, B.A. 80 or 81, B.A. 220b, Econ. 1b or 2b.

283. Institutional Investment and Lending Policies (3) I
Denton
Critical examination of the determining factors in the allocation of fund to various types of investment—mortgages, corporate bonds, ownership of real estate, government bonds, et al.—by banks, savings and loan associations, insurance companies, pension funds, and other institutions which accumulate savings of individuals. Legal forms, state and federal requirements, and regional influences will be investigated.

301. Human Relations in Administration (2) II
Ireland-Leonard
(Identical with Soc. 301)
302. Employer-Employee Relations (3) I
Leonard
A study of the employee-relations function in industry. The relationship of the employee-relations function to the overall purposes of industrial organizations. The nature, purpose, and techniques of major components of the employee-relations function.

349. Bank Organization and Management (3) I 1959-60
Monroe
Problems of bank organization; responsibilities of officers and directors; relationship of correspondents, government agencies, and the money market. Management of bank funds; bank credit, and bank policies. P, Econ. 248. Open to qualified seniors and graduate students.

353. Advanced Property and Casualty Insurance (3) II 1960-61
Roos
Study of risk appraisals, analysis of current trends in the property and casualty insurance field. P, 257 and 258.

355. Research Methods in Business (3) I, II
Hoflich
Inquiry into objectives and methods of business research; study of contemporary research projects in business; the organization of industrial research in a business enterprise. P, 135 and graduate standing.

356. Sampling Theory and Methods (3) II 1959-60
Staff
Theory and applications of sampling methods useful in various areas of business and governmental operations and research. Experimental design. P, 115 or equivalent. (Identical with Mkt. 356)

358. Intermediate Statistical Analysis (3) II 1960-61
Staff
Probability; distributions; extension of sampling theory; curvilinear and multiple correlations; contingency; other topics. P, 155. Open to qualified seniors.

371. Business Policies (3) I
Gill
A course using the case method which deals with problems and politics facing top management. P, 272.

372. Administrative Report Writing (3) II
Gill
A course to help the student to present analytical thinking in written reports. These will be spaced throughout the semester and will be made on specific business situations giving evidence of the student's ability to organize his thinking and present concise reports for evaluation. A study of the availability, location, and use of source material. P, 355 and 371.

373. Management Problems (2) I
Brown
A course dealing with top management problems and suggested solutions. P, 272.

374. Techniques of Supervision (3) I 1959-60
Gill

393. Business Investigation and Reports (2) I, II
Staff
Methods of locating, classifying, and evaluating information; form and mechanics of writing a thesis on the findings. The thesis must be typed and bound in accordance with manual published by University of Arizona Bookstore. Open to seniors graduating within two semesters.

399. Seminar (2 to 4) I, II
Staff
Open to seniors with consent of the instructor. Content confined to some special field such as area development, finance, geography, real estate et al., depending upon student need and availability of staff.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 4) I, II
Staff

410. Thesis (4) I, II
Maximum total credit permitted, 4 units

CHEMICAL ENGINEERING

Professor Donald H. White, Ph.D., Head
Assistant Professor Robert A. Damon, Ph.D.
Instructor
Graduate courses and research leading to Master of Science degree are offered by the Department of Chemical Engineering. For admission to graduate study, candidates must show completion of course work equivalent to that required by the University of Arizona for the Bachelor of Science degree in chemical engineering.

220. Chemical Engineering Operations Laboratory (2) I Edwards
Laboratory investigations of operating characteristics and efficiency of unit operation equipment. 6L. P, 112b. Fee, $5.

221. Chemical Process Laboratory (2) II Edwards
A project is developed by programming and operating a pilot plant. Experimental data are obtained and used in preparing a preliminary process design. 6L. P, 220. Fee, $5.

230. Intermediate Chemical Engineering Thermodynamics (3) II Damon
A continuation of applications of thermodynamics to physical and chemical equilibria encountered in chemical engineering processes and calculation of thermodynamic properties of industrial substances. P, 130.

240a-240b. Chemical Engineering Design (2-2) Yr. White-Edwards
Principles of process design and plant design involving equipment design, preliminary process design, and estimation of capital investment, manufacturing costs, and plant economics. 6L. P, 112b.

250. Chemical Industries Economics (3) I White
Study of problems, inter-commodity and inter-process relationships of the chemical industries; economies of plant location, transportation, and related factors; research, pilot plant developments, market developments, and patent aspects; and economic significance of current developments in chemical industries. P, 112b and 121.

260a-260b. Chemical Engineering Computations I, II (2-2) Yr. Damon
First semester involves applications of mathematical principles to complex chemical engineering problems, emphasizing problems adaptable to solution using digital computers. Second semester applies mathematical principles to kinetics and dynamic systems analysis, which can be simulated on analog computers. P, 112b and Math. 180.

310a-310b. Advanced Chemical Engineering Principles (3-3) 1959-60 Yr. Staff
Theory and applications of chemical engineering principles and unit operations, with special emphasis on new concepts being currently developed. P, 112b or equivalent.

330. Advanced Chemical Engineering Thermodynamics (3) 1960-61, I Damon
Advanced applications of thermodynamics to chemical engineering operations and processes. P, 230 or equivalent.

340a-340b. Advanced Chemical Engineering Design (3-3) Yr. Staff
A selected, integrated series of project items extending the principles taught in 240a-240b. P, 240b or equivalent.

350. Advanced Chemical Industries Economics (3) II White
Applications of principles taught in 250 in the evaluation of major current developments in the chemical industries on an intensive and detailed basis. P, 250 or equivalent.

360a-360b. Advanced Chemical Engineering Computations (3-3) Yr. Damon
A selected, integrated series of problems extending the principles taught in 260a-260b. P, 260b or equivalent.

370. Polymers Industries Technology (3) 1959-60 I White
Kinetics and mechanism of formation, manufacturing processes technology, and evaluation of uses and economics of plastics, elastomers, natural fibers, and synthetic fibers. P, Chem. 140a-140b and 250, or equivalent.

371. Plastics Technology (3) 1960-61 II Carley
Chemical formulations and modifications of plastics resins; compounding technology; cross-linking; economic evaluation of major plastics products fabricated by various techniques; competitive position with other materials of construction; and comparison of physical properties. P, 250 or equivalent and Chem. 140a-140b or equivalent.

372. Water and Wastes Treatment (3) 1959-60 II White
The principles of water treatment, sewage disposal, and industrial wastes treatment, as related to chemical industries. P, 112b, or equivalent.
381. Automatic Process Control (3) 1959-60 II

Analysis and design of automatic control systems for chemical engineering operations and processes. P, 112b, or equivalent, and Math. 180.

399. Seminar (1) I, II

Reports on current research and assigned topics. Required of students registered for 400 or 410.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (1 to 5) I, II

410. Thesis (2 to 6) I, II

Maximum total credit permitted, 8 units

CHEMISTRY

Professors Henry Freiser, Ph.D., Head, Reuben G. Gustavson, Ph.D., Robert L. Nugent, Ph.D., Herbert D. Rhodes, Ph.D., Millard G. Seeley, Ph.D.

Associate Professors Edward N. Wise, Ph.D., Douglas S. Chapin, Ph.D., Leslie S. Forster, Ph.D.

Assistant Professors James W. Berry, Ph.D., Roy A. Keller, Ph.D., Alec E. Kelley, Ph.D., Cornelius Steelink, Ph.D.

The Department of Chemistry is equipped adequately to conduct research in analytical, inorganic, organic and physical chemistry, and biochemistry. New students will be assisted and advised by the department's advisory committee until such time as they are prepared to select a research problem and adviser according to the departmental procedure presented in the pamphlet, "Selecting a Research Problem and a Research Adviser." In order to make itself a more effective agency for the guidance of beginning students, the advisory committee administrators, during Freshman Week, examinations in analytical, organic, and physical chemistry to all students entering graduate work. Examination results are used in helping the student plan his program. Deficiencies in undergraduate work must be made up without graduate credit.

Master of Arts. — Students beginning work for the Master of Arts degree must have completed a course equivalent to that required for the Bachelor of Arts with a major in chemistry. The work leading to this degree is designed for those who do not plan to enter chemistry as a profession, or to continue work toward the Doctor of Philosophy degree. Students who plan to teach chemistry in secondary schools will find this work adapted to their needs. Of the 15 units in the major subject, not more than five may, with the approval of the head of the department, be chosen in a closely related field. At least six units of the work in chemistry must be in courses numbered 300 or above, not including the thesis. A thesis is required, but, at the discretion of the head of the department, need not embody the results of experimental work. In no case will more than four units of credit be given for the thesis. If the major is divided between chemistry and another subject, not more than two units will be given for the thesis. If the minor is not in a related scientific field, not more than 10 units of credit may be devoted to the minor. The examinations for this degree will conform to the policy set forth for the Master of Science degree, except that the preliminary examination in organic chemistry will not cover Chemistry 240.

Master of Science. — Students beginning work for the Master of Science degree must have completed a course equivalent to that required for the Bachelor of Science with a major in chemistry. Before admission to candidacy, the student must pass a preliminary examination (not fewer than two months nor more than two years prior to the final oral examination), unless this examination is waived by the department in consideration of his superior performance. The candidate must pass a comprehensive written examination not more than two weeks, nor fewer than two days, prior to the final oral examination.
**Doctor of Philosophy.** — Students beginning work for the Doctor of Philosophy degree must have completed a course equivalent to that required for the degree of Bachelor of Science with a major in chemistry. Requirements for this degree are given on page 42. The final examination will include both written and oral examinations.

*See page 38 for Master of Education degree major or minor in this department.*

**Note:** A breakage deposit of $2.50 is required of all laboratory courses listed below except 212, 220, 240, 246, 261a, 261b, 281a, 281b, 312, in all of which courses the deposit is $8.

210. Intermediate Inorganic Chemistry (3) I 1960-61  
Staff  
A study of the properties, preparation, and reactions of the elements and their correlation as given by the Periodic Table. 3R, P, 20b.

212. Inorganic Preparations (3) II 1960-61  
Staff  
A laboratory course designed to acquaint the student with the fundamental preparations and reactions of inorganic chemistry. 1R, 6L, P, 20b, 210. Fee, $8.

220. Intermediate Quantitative Analysis (3) I  
Freiser-Wise  
Modern non-instrumental quantitative analysis emphasizing separations and complex samples. 1R, 6L, P, 20b. Fee, $7.

222. Instrumental Methods of Analysis (3) II  
Wise  
Theory and practice of the more common instrumental methods of analysis with emphasis on optical and electrical methods. 1R, 6L, P, 20b. Fee, $7.

240. Qualitative Organic Analysis (3) I  
Berry  
The systematic classification and identification of organic compounds. 1R, 6L, 20b, 140b, and a reading knowledge of German. Fee, $8.

242. Organic Reactions (3) II  
Berry-Kelley-Seeley-Steelink  

246. Organic Preparations (3) II  
Berry-Kelley-Steelink  
Special experimental methods for the synthesis of organic compounds. 1R, 6L, 140b. Fee, $8.

260a-260b. Biochemistry (3-3) Yr.  
Staff  
General principles of biochemistry including carbohydrates, lipids, proteins, digestion, metabolism, blood, urine, and biochemical regulators. Special emphasis is given to current developments. P, 20a, 140b.

261a-261b. Biochemistry Laboratory (2-2) Yr.  
Chapin-Forster-Keller  
Laboratory problems in physical chemistry. 6L. P, for 261b, Math. 79b. Fee, $7.

280a-280b. Physical Chemistry (3-3) Yr.  
Forster  
Fundamental principles of physical chemistry. P, 20b; Math. 79; Physics 2b or 15.

281a-281b. Physical Chemistry Laboratory (2-2) Yr.  
Chapin-Forster-Keller  
Laboratory problems in physical chemistry. 6L. P, for 281b, Math. 79b.

288. Surface Chemistry and Colloids (3) I  
Chapin  
The physical chemistry of surfaces and colloids. P, 280b.

300. The Chemical Bond (3) I  
Forster  
An introduction to modern structural chemistry; the nature of the chemical bond and the structure of molecules and crystals presented on the basis of modern theory. P, 280b.

310. Advanced Inorganic Chemistry (3) II  
Staff  
Lectures, discussions, and reports covering the chemistry of the common and less familiar elements, with special emphasis on recent developments. P, 280b.

312. Radiochemistry (2) II 1959-60  
Wise  
Chemical applications of radioelements. 1R, 3L, P, 280b, Physics 150.
320. Advanced Analytical Chemistry (3) II  Freiser
A lecture course concerned especially with advanced aspects of ionic equilibria, design of experiments, statistical treatment of data, and separation processes. P, 280b.

322. Electroanalytical Methods (3) I 1960-61  Wise
Principles of chemical analysis based on reactions at metallic electrodes in contact with electrolyte solutions, and with the passage of electricity through electrolyte solutions. P, 222, 280b, 281b.

324. Analytical Separation Processes (3) II 1959-60  Freiser
Principles and applications of analytical separation processes including precipitation, solvent extraction, chromatography, ion exchange, and volatilization. P, 320.

340a-340b. Advanced Organic Chemistry (3-3) Yr.  Kelley

344. Heterocyclic Compounds (3) I 1960-61  Steelink
A discussion of the behavior of the more important heterocyclic systems. P, 340b.

346. Organic Nitrogen Compounds (2) II 1959-60  Kelley-Steelink
The chemistry of aliphatic and aromatic amino, nitro, and diazonium compounds. P, 304b.

360a-360b. Advanced Biochemistry (3-3) Yr.  Staff
Advanced treatment of topics in enzymology, intermediary metabolism, vitamin and mineral function, hormonal control of metabolism, and biochemistry of neutral tissue. P, 260b, 280b.

362. The Carbohydrates (2) II  Berry-Steelink
The structure, stereochemistry, and chemical behavior of the carbohydrates and polyuronides. P, 340b.

364. Chemistry of Natural Products (3) II 1960-61  Steelink
Isolation, structural elucidation, total synthesis, biogenesis, metabolism, and physiological importance of natural products, as exemplified by terpenes, pigments, and phenolics. P, 340b.

366. Mechanisms of Enzyme Action (3) I 1959-60  Staff
Application of physical chemistry to a study of enzyme action, kinetics, and specificity. P, 360b or Biochemistry 312.

380a-380b. Advanced Physical Chemistry (3-3) Yr.  Keller
An advanced survey of physical chemistry. The first semester is devoted to the kinetic theory of gases and chemical kinetics. The second semester is a course in thermodynamics with applications to thermochemistry, chemical equilibrium, and electrochemistry. P, 280b.

381a-381b. Chemical Thermodynamics (3-3) Yr.  Chapin
Principles of thermodynamics with applications to thermochemistry, chemical equilibrium, and electrochemistry. P, 280b.

382. Statistical Thermodynamics (3) II 1959-60  Keller
Fundamental principles of classical and quantum statistics, with applications to chemical equilibrium and kinetics. P, 381a.

384. Chemical Kinetics (3) I  Chapin-Forster-Keller
The study of chemical reaction rates and mechanisms. P, 280b.

385. Theory of Solutions (3) II 1960-61  Keller

386. Quantum Chemistry (3) II  Forster
Principles of quantum mechanics with applications to the properties of molecules. P, 300.

398. Special Topics (1 to 5) I, II  Staff
This course may be elected only by students preparing for the doctoral degree who wish to pursue topics not covered in regularly scheduled courses. Arrangements must be made with the appropriate staff member and the department head before registration.

399. Seminar (1) I, II  Staff
Reports on current research and assigned topics. Required of all graduate students in the department.
INDIVIDUAL STUDIES

400. Research (1 to 5) I, II
 Fee, $1 per unit.

410. Thesis (1 to 5) I, II  Maximum total credit permitted, 8 units

420. Dissertation (1 to 9) I, II

CIVIL ENGINEERING

Professors Gene M. Nordby, Ph.D., Head, Erasmus S. Borgquist, C.E., David J. Hall, M.S., Quentin M. Mees, M.S., Henry J. Miles, Ph.D., Richmond C. Neff, Ph.D., John C. Park, M.S., Andrew W. Ross, M.S.

Associate Professors Maurice Lagaard, C.E., Philip B. Newlin, M.S.

Assistant Professors James Kriegh, M.S., Lewis K. Oesterling, C.E.

The department offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees in civil engineering and in engineering mechanics.

Advanced work in civil engineering and engineering mechanics is directed toward research and professional development in several fields including the following: applied mechanics and engineering materials, area development and urban planning, highway engineering, hydraulics and fluid mechanics, sanitary engineering, soil mechanics and soil science, structural engineering, and transportation. Excellent facilities for individual research are available in each of these areas. Acceptable fields of minor study include architecture, chemistry, geology, mathematics, mechanical engineering, metallurgy, mining engineering, nuclear engineering, numerical analysis, and physics. Other fields may be used as minor areas upon the approval of the head of the department. For admission to graduate work in civil engineering and engineering mechanics, an undergraduate major in these fields is normally required; however, applicants with undergraduate majors in the other physical sciences and engineering fields are encouraged to apply. Training in such fields provides an excellent background for approaching some areas of graduate study in this department.

201. Intermediate Mechanics (3) I  Neff
 Foundations of mechanics, kinematics, virtual work, constraints, generalized coordinates, Lagrange's Equations, Hamilton's Principle, principle of least action, theory of small oscillations, vibrations of discrete and continuous systems. P, 6, Math. 180, Phys. 20, ME 130 or CR.

206. Advanced Mechanics of Materials (3) I  Neff
 Analysis of stress and strain, theories of failure; cylinders, spheres, and disks under radially symmetric loads; advanced topics in flexure, torsion, and buckling. P, 6, Math. 180.

210. Applied Elasticity I (3) I  Neff

211. Applied Elasticity II (3) II  Neff

212. Plates and Shells (3) II  Nordby
 Theory and design of circular, rectangular, and continuous plates, shells, warped or doubly curved structures, cylinders, and intersection shells by classical, numerical, and approximate methods. P, 6, Math. 180.

213. Theory of Elastic Stability (3) II  Staff
 Bending and buckling of prismatic bars, beams, rings, curved bars, thin shells, and thin plates under axial and lateral loads. P, 6, Math. 180.
215. Introduction to the Theory of Plasticity (3) II Neff
Theories of plastic flow and deformation; theories of the ideal plastic and strain hardenable material; applications to simple states of stress. Plastic design of beams, columns, pressure vessels, and shafts. Plastic deformation in extension, drawing, and other metal forming operations. P, 6, Math. 180.

218. Experimental Stress Analysis (3) II Neff
Theory and application of photo-elastic, electric resistance strain gage, brittle lacquer and brittle model methods of experimental stress analysis. Static loading and two-dimensional models will be emphasized. 2R, 3L. P, 131 or ME 152. Fee, $5.

222. Hydraulic Engineering (3) II Miles
Theories and principles concerned with the planning, construction, and operation of structures to utilize natural waters. 2R, 3L. P, ME 130. Fee, $4.

223. Hydrology (2) II Miles-Fonken
(Identical with Agricultural Engineering 220)

224. Open Channel Flow (2) I Miles
Classification of types of flow, hydraulic jump analysis, similitude, energy dissipation, supercritical velocity flow, transitions, scour, and transportation of sediment; current developments in theory and design. P, ME 130.

232. Advanced Structural Analysis (3) I Kriegh-DaDeppo
Advanced problems in structural analysis including arches, frames with members of variable cross-section, multi-span frames, composite structures, cable structures, and space frames. P, 131, Math. 180.

236. Structural Design in Metals (3) I Ross
Structural design in steel, aluminum, and other metals, including: design of tension, compression, and flexural members; design of welded, riveted, and bolted connections; introduction to plastic design. 2R, 3L. P, 131. Fee, $2.

237. Structural Design in Reinforced Concrete (3) I Kriegh-Nordby
The theory and design of reinforced concrete structures including beams, girders, slabs, columns, foundations, walls, and buildings. 2R, 3L. P, 131. Fee, $2.

240. Advanced Soil Mechanics (3) II Nordby-Hall
The physical, chemical, and mechanical properties of soils as related to engineering works, including: shear strength, slope stability, consolidation, bearing capacity, foundations, earth pressures, earth dams; review of current research. P, 140, 180, 206 or 210.

241. Foundations (2) II Ross-Park-Linville
The theory and design of footings, caissons, cofferdams, and other substructures combining the use of soil mechanics and structural analysis. P, 140, 180, 236, 237.

253. Geodetic Surveying (3) I Newlin
Refinements in the branch of surveying by which latitudes, longitudes, and elevations of points on the earth's surface and the form and dimensions of the earth are determined; adjustment of triangulation systems and level nets by the method of least squares; methods of surveying and computing as practiced by the U.S. Coast and Geodetic Survey and the U.S. Geological Survey. 1R, 6L. P, 152 and Math. 180. Fee, $6.

254. Photogrammetry (3) II Newlin

260. Transportation Engineering (3) I Hall-Linville
The dominant types of transportation; theory of wheels; theory of vehicle loading and resistances, design of wheel-supporting structures. P, 140, 180, Math. 180.

261. Transportation Engineering II (3) II Hall-Linville-Park
The energy and economic aspects of transportation from the executive engineer's viewpoint; problem solving and decision processes, money, and administration. P, 260.

263. Highway Traffic and Safety (3) I Hall
Analysis of basic characteristics of traffic movement, such as volumes, speeds, origins, and distributions, delays, road capacity, and accidents. Techniques for making traffic engineering investigations. 2R, 3L. P, 260 or CR. Fee, $2.
264. Traffic Engineering: Operations (3) II
   Hall
   Theory and practical application of traffic engineering to operation on the highways
   and streets; parking control and public transit planning; traffic engineering administra-
   tion. P, 263.

265. Urban Planning (3) II
   Hall-Mees
   Survey of contemporary city and metropolitan planning theory and method from
   the engineering viewpoint; role of physical planning in local government; city govern-
   ment types; method of plan preparation and effectuation; relationships to transportation
   and municipal engineering. 2R, 3L. P, senior standing. Fee, $2.

270. Water Supply and Waste-Water Disposal (3) I
   Mees
   The scientific principles of water supply and waste-water disposal. P, ME 130.

271. Sanitary Engineering Science (3) II
   Mees
   Laboratory tests, unit processes, scientific techniques, and procedures used in water
   supply and waste-water disposal practice and design. 2R, 3L. P, 270. Fee, $4.

290. Civil Engineering Design (3) II
   Staff
   Individual design study in a field of the student's choice in sanitary, structural, high-
   way, hydraulic, or other engineering, or completion of a research and development
   project under direct staff supervision. P, senior standing or consent of department.
   Field trip fee not to exceed $35 will be collected when trip is arranged.

292. Numerical Methods in Engineering (3) I, II
   Staff
   Numerical approximation methods applied to engineering problems: Numerical
   differentiation and integration, curve fitting, roots of polynomial and transcendental
   equations, introduction to finite differences, relaxation. Laboratory in programming and

295. Similitude in Engineering (3) I
   Miles
   Dimensional analysis; design and analysis of scaled, distorted, and dissimilar models.

296. Economic Problems for Engineers (3) II
   Clark
   (Identical with Electrical Engineering 132) P, senior standing in engineering.

297. Contracts, Specifications, and Engineering Relations (2) II
   Park
   P, senior standing.

298. Civil Engineering Seminar (1) II
   Borgquist
   Preparation, presentation, and discussion of engineering reports on assigned sub-
   jects. P, senior standing.

310. Theory of Elasticity (3) I
   Neff
   Stress and strain tensors in curvilinear coordinates. Torsion, flexure, flat plates, shells

311. Advanced Problems in Elastic Stability (3) II
   Staff
   Buckling of compression members, flexural members, flat plates, shells, and tubes.

318. Advanced Experimental Stress Analysis (3) I 1960-61
   Neff
   Separation of stresses, three-dimensional problems, scattered light and oblique
   incidence methods in photo-elasticity. Calibration of variable resistance strain gages
   and corrections for biaxial loading conditions. Measurement and interpretation of

323. Advanced Hydraulics (3) I
   Miles
   Treatment of advanced problems in hydraulics, including: river mechanics, wave
   mechanics and beach erosion, sediment transport, spillway and reservoir design,

324. Hydrodynamics I (3) I 1960-61
   Miles
   Fundamentals of frictionless fluid flow, theorems and basic definitions, three-
   dimensional examples, application of complex variable to two-dimensional flow. P, ME
   130, Math, 180.

325. Hydrodynamics II (3) II 1960-61
   Miles
   Flow around cylinders and hydrofoils, free streamlines, vortex motion, equations for
   viscous flow, boundary layer theory. P, 324.

333. Vibrations of Structures (3) II
   Neff-DaDeppo
   Vibrations of beams and frames, effects of shear and rotary inertia, response to
   moving loads, introduction to vibrations of slabs, and sources of shaking forces. P, 131,
   206, or 210.
336. Advanced Structural Design in Metals (3) II
   Ross
   Advanced structural design in steel and aluminum alloys; experience in design under
design codes; relation of code requirements to theories of material behavior; advanced
plastic design. P, 232, 236.

337. Advanced Reinforced Concrete Theory and Design (3) I
   Nordby-Ross
   Ultimate strength design, design of prestressed concrete, folded plates, shell roof
structures, theory of failure of concrete members, and review of current research.
P, 131, 237.

342. Advanced Soil Mechanics Laboratory (3) I
   Hall-Nordby
   A laboratory study of the mechanical, physical, and hydraulic properties of soil

364. Highway Planning and Economics (3) I
   Hall
   Application of the results of planning surveys in programming highway improve-
ments, economic analysis of highway improvements, parking, and zoning studies;

365. Advanced Highway Engineering (3) II
   Hall
   Theory and practice in the design of alignment, highway cross-sections, intersections,
interchanges, multiline expressways, and arterial highways. 2R, 3L. P, 261, 263.
Fee, $2.

374. Industrial Waste Treatment (3) II
   Mees
   Industrial waste and stream pollution surveys, current control measures, the problem
20a or 21a. Fee, $5.

375. Advanced Waste-Water Disposal System Design (3) I
   Mees
   Administration, financing, design, construction, and operation of waste-water dis-
posal systems. 2R, 3L. P, 271, Chem. 20a or 21a. Fee, $5.

376. Theory and Design of Water Distribution and
   Treatment Facilities (3) II
   Mees
   Administration, financing, design, construction, and operation of water treatment
plants and distribution systems. 2R, 3L. P, 271, Chem. 20a or 21a. Fee, $5.

377. Engineering in Public Health (3) I
   Mees
   The application of engineering principles directed toward the control of the environ-
ment for the protection and the improvement of the health and comfort of man;
including disease and immunity, epidemiology, biostatistics, industrial hygiene, and
problems in sanitation. P, 271, Bact. 17 or 117a.

INDIVIDUAL STUDIES

299. Special Problems (2 to 5) I, II

400. Research (2 to 5) I, II

410. Thesis (3 to 6) I, II Maximum total credit permitted, 6 units

420. Dissertation (1 to 9) I, II

CLASSICS

Professor Garnet D. Percy, Ph.D., Head
Associate Professor Donald M. Ayers, Ph.D.
Instructor Edward E. Best, Ph.D.

No advanced degree in classics is offered. In addition to a number of courses open with the consent of the instructor to all graduate students, the department offers one course, Classic 400, restricted to those who are doing research involving the use of the Greek and Latin languages and who have been admitted to candidacy for an advanced degree in the University.

See page 38 for Master of Education degree major or minor in this department.

201a-201b. Greek and Latin Reading Course (4-4) Yr.
   Gross-Best
   Readings from Greek or Latin literature, conferences, and reports. P, 101b or 110b.
   May be repeated for credit without duplication of work.
INDIVIDUAL STUDIES

399. Seminar (3) I, II

400. Research (2 to 8) I, II
Open to students who have been admitted to candidacy for advanced degrees.

CLIMATOLOGY
(See Meteorology and Climatology)

DAIRY SCIENCE

Professors Vearl R. Smith, Ph.D., Head, J. Warren Stull, Ph.D.
Associate Professor Robert G. Fossland, Ph.D.
Assistant Professor Gerald H. Stott, Ph.D.

The Department of Dairy Science offers the Master of Science degree in either of two fields: dairy technology or dairy production. In addition to study in the department, students are expected to take certain courses in bacteriology and chemistry. Courses in these latter fields may be applied to the major.

The department cooperates with the Committee on Biochemistry and Nutrition in offering a graduate major in nutrition with course work leading to the Master of Science and Doctor of Philosophy degrees.

(Identical with Animal Science and Poultry Science 210)

215. Physiology of Reproduction and Milk Secretion (4) I Fossland
(Identical with Animal Science 215)

306. Dairy Chemistry (3) II 1960-61 Stull
The chemical composition and the biological significance of the constituents of milk; some technical problems associated with the physio-chemical properties of the milk constituents. P. Chem. 260a and 261a or equivalent.
(Identical with Agricultural Biochemistry and Nutrition 306)

399. Seminar (1) I, II Staff
Offered jointly with the departments of Animal Pathology, Animal Science, and Poultry Science.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units

DRAMA

Professor Peter R. Marroney, M.A., Head, ————
Associate Professor Robert C. Burroughs, M.A.
Assistant Professor John E. Lafferty, M.F.A.
Instructor Susan J. Gullberg, M.A.

The Master of Arts degree is offered in all fields of theater arts and crafts. The University of Arizona is fortunate in possessing the T. E. Hanley Collection
of dramatic arts material and the Thomas Wood Stevens Memorial Theater Collection. The University Library has a fine collection of books covering the fields and allied branches of the theater. The Department of Drama has its own separate facilities for play-production activities. These include rehearsal laboratory and public performance space; workshops for the design and construction of scenery, costumes, and lighting. The production schedule of the department includes three separate series: a group of major productions of four plays and one musical, in cooperation with the School of Music; a series of theater-in-the-round productions of two or three plays annually; a graduate experimental series where graduate students direct well-known classical dramas. The weekly laboratory theater presents scenes from great one-act plays, and original scripts. The department also cooperates with state and local groups in the presentation of special programs. Two tours are sponsored by the department: one throughout the state of Arizona; the second as an inter-studies program of the Arizona-Sonora region with the University of Sonora in Hermosillo, Mexico.

The prerequisites for the advanced degree include 12 to 18 semester hours in technical fields of the theater, i.e., lighting, stagecraft, scene design, and stage costing; 12 semester hours of acting and directing; 6 semester hours of history of the theater or of drama survey.

220a-220b. Problems of Stage Lighting (3-3) Yr. Lafferty
Lighting for styles of productions. Special problems; practice and trends in modern lighting, instrument selection, cost, and adaptability. 2R, 1L. P, 20, 21, 123b.

223a-223b. Scene Design II (2-2) Yr. Burroughs
Chronological study of scenic decor from Egypt to the present and its relation to staging methods; design problems involved in various types of contemporary productions. Opportunity for participation in production design. P, 123a-123b or its equivalent in art.

236. The Oral Interpretation of Shakespeare (3) I Mattingly
(Identical with Speech 236)

240a-240b. History of the Modern Theater (2-2) Yr. Ryan
Study of modern trends in drama through class analysis and reports on leading modern dramatics from Ibsen to the present day. P, 40a-40b, or equivalent in literature.

245. Advanced Oral Interpretation (3) II Mattingly
(Identical with Speech 245)

260a-260b. Playwriting (2-2) Yr. Ryan
The practical application of playwriting principles achieved through a series of creative exercises and writings. In 260a, emphasis is on the one-act play; in 260b, on the full-length play. P, 40a-40b, senior standing.

280a-280b. Problems in Stage Costume (3-3) Yr. Gullberg
Individual projects in designing, execution, organization, and production of stage costumes, including regional and national. P, 41a-41b.

300. Introduction to Graduate Study of Drama (1) I Ryan
The study of and methods used in compiling bibliography, assembling research material, and choosing topics and themes for theses. Required of all graduates in drama.

323a-323b. Technical Problems (3-3) Yr. Burroughs
Production organization; advanced scenic construction; theater design in regard to academic, professional, and civic buildings; stage planning, including types of shifting devices; advanced scene-painting techniques. P, 20, 21, 123a-123b.

327a-327b. Problems of Theater Organization and Management (2-2) Yr. Staff
Study of theater management, organization, exploitation, financing, and other phases of the university, community, and high-school theater. P, 12 units of drama, including 6 upper-division.

340a-340b. Play Analysis and Criticism (3-3) Yr. Ryan
A survey of dramatic structure and trends; theories of dramatic criticism, important critics, and examples of criticism; research and prepared papers applying the aspects of play analysis and criticism.

See page 38 for Master of Education degree major or minor in this department.
355a-355b. Problems of the Production Director (3-3)Yr. Marroney
The adaptation of directional philosophies; setting up production policies; analysis of copyright, royalty, and equity laws; producing original and experimental drama. P, 20, 21 or 111a-111b, 155a-155b.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 5) I, II
410. Thesis (2 to 4) I, II  Maximum total credit permitted, 4 units

ECONOMICS

Professors Philip G. Hudson, Ph.D., Head, Elmer J. Brown, Ph.D., Lauren W. Casaday, Ph.D., Andrew B. Schmidt, A.M., Glen W. Strickler, M.A.

Associate Professors William H. Fink, Ph.D., Gilbert L. Gifford, Ph.D.

Assistant Professors Vincent F. Boland, Ph.D., Patrick Huntley, M.A., John W. Leonard, Ph.D., Robert H. Marshall, Ph.D., Leahmae McCoy, Ph.D.

Instructors John W. Cordell, M.A., Bernard P. Herber, M.A.

Work leading to the degree of Master of Arts with a major in economics is offered for graduates of recognized colleges whose undergraduate work includes 24 semester units in economics passed with satisfactory grades. Since there is no sharp dividing line between economics and business administration, consideration will be given to the content of course rather than its designation.

A graduate program combining two closely related fields may be arranged with the permission of the head of the department. Supporting courses or a minor should be chosen from related fields such as sociology, philosophy, history, government, or anthropology, in which the student has had not fewer than 6 undergraduate units.

The Department of Economics offers some of the supporting courses for the degrees of Master of Business Administration and Master of Public Administration.

Library facilities are good with particular reference to periodicals and governmental documents. The Bureau of Business and Public Research offers many worthwhile projects for research in fields of interest to students of economics. Of particular significance is the opportunity to do independent study with the direction and counsel of a member of the staff of the Bureau.

203. Economic History of Europe (3) I Herber
A survey of the economic evolution of Europe. P, 1b or 2b.

204. Economic History of the United States (3) II Herber
A study of the development of the economic institutions of the United States. P, 1b or 2b.

205. Labor Problems and Trade Unionism (3) I, II Staff
The labor movement; problems and risks of wage-earners in modern economic society; structural and functional types of unions; union policies and practices; unions and the law. P, 1b or 2b.

206. Industrial Relations (3) II Staff
Problems arising out of employer-employee relations, the law of collective bargaining; wages and hours legislation; regulation of the unions; industrial peace; the collective bargaining agreement. P, 101 and junior standing for students in the Colleges of Engineering and Mines. P, for other students, 1b or 2b.
207. Comparative Economic Systems (3) II Schmidt  
A critical analysis of capitalism, socialism, communism, and fascism. P, 1b or 2b.

217. International Economic Relations (3) I  
Principles underlying the commercial and financial relations among countries; foreign exchange and international investment; evaluation of various forms of restrictions and controls. P, 248.

221. Transportation (3) I Gifford  
History of transportation; organization; finance, theory of rates, rate structures; regulations by the states and the federal government; motor transportation. P, 1b or 2b.

222. Public Utilities (3) I Gifford  
Economics of telephone, gas, and electric power industries, emphasizing rates, regulation, financing, and taxation. P, 1b or 2b.

223. Current Transportation Problems (3) II Gifford  
Present transportation regulations, government provision of transportation facilities; subsidies to carriers, pricing, costs. P, 1b or 2b, 221.

225. Industrial Traffic Management (3) II Gifford  
Transportation from the viewpoint of the shipper; rates and services of the various carriers, classifications and rules, freight rates and tariffs. P, 1b or 2b, 221. (Identical with B.A. 225)

245. Public Finance (3) I, II  
Public expenditures; taxation; public debt. P, 1b or 2b.

248. Money and Banking (3) I, II Staff  
A comparison of various standards of value; the nature of money and credit, the essential functions of commercial banks and the Federal Reserve system; foreign exchange and the Monetary Fund and International Bank. P, 1b or 2b.

272. Government and Business (3) I Strickler  
Changes in the relations of government to business and the philosophies underlying them. P, 1b or 2b.

307. History of Economic Thought (3) I Schmidt  
Development of economic thought from ancient times to the present. P, 291.

308. Managerial Economics (3) II  
The application of economic theory to problems of business management. P, 135, 291, and graduate standing.

309. Evolution of the Labor Movement (2) I Staff  
The development of the labor movement and the forms of labor organization from earliest times to the rise of the American Federation of Labor.

310. The Modern American Labor Movement (3) II Leonard  
A critical and intensive survey of the American labor movement from about 1885 to the present time. Individual readings and reports will be required.
345. Problems in Taxation (3) II 1960-61 Hudson
Problems of revenue, expenditures, and debts of state and local units of government,
with special reference to Arizona. P, 245 and graduate standing.
(Identical with Pub. Adm. 345)

349. Advanced Problems in Money and Banking (3) II Fink
Analysis of banking institutions and money, monetary theory, and monetary policy;
problems of monetary management and evaluation of programs for monetary and

351. Theory of Social Insurance (2) I McCoy
An analysis of the economic and social hazards of old age, disability, unemployment,
and accident and poor health in the United States, and a critical examination of social
insurance as a way of dealing with these hazards. P, graduate standing.

372. Government Controls and Business Enterprise (3) II Strickler
Critical survey of American government controls over business enterprise, economic
conditions necessitating controls and the type of controls imposed, their effectiveness
and defects. Probable future alternatives in existing controls and control methods. P,
graduate standing.

391. Advanced Economic Theory (3) I 1960-61 Boland
Production and exchange theory. Classical and general equilibrium analysis. Partial
analysis; Marshall and the Cambridge school. Real cost analysis and the choice criterion;
Hicks and the London school. Profit maximization versus risk-evasion; game theory.
P, graduate standing.

392. Economic Investigations and Reports (2) I, II Staff
Methods of locating, classifying, and evaluating information; preparation, form, and
mechanics of writing a thesis on the findings. The thesis must be typed and bound
in accordance with manual published by the University of Arizona Bookstore. Open
to seniors graduating within two semesters.

399. Seminar (2) I, II Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 4) I, II

410. Thesis (4) I, II Maximum total credit permitted, 4 units

EDUCATION

Professors Curtis B. Merritt, Ph.D., Acting Dean, Robert A. Crowell, Ed.D., Oliver
K. Garretson, Ph.D., Victor H. Kelley, Ph.D., Emil L. Larson, Ph.D., Lloyd E. McCann, Ed.D., Russell W. Cline, Ph.D. (Agricultural Education),
A. Laurence Muir, Ph.D., (English).

Associate Professors Paul J. Danielson, Ph.D., Emil S. Gavlak, D.Ed., Jack E.
Hansma, Ed.D., Jacob T. Hunt, Ph.D., Thadeus C. Johnston, Ed.D., Gene-
vieve Syverson, Ph.D.

Assistant Professors Donald N. Bentz, M.S.L.S., Milo K. Blecha, Ed.D., Robert
E. Calmes, D.Ed., William W. Crowder, Ph.D., John A. Haberland, Ph.D.,
William H. King, Jr., D.Ed., Raymond L. Klein, Ed.D., Robert J. Letson,
Ed.D., J. Melvin Rhodes, Ph.D., Elinor C. Saltus, A.M.L.S., Arthur H. Stein-
brenner, Ph.D., David W. Smith, D.Ed., Wilson F. Wetzler, Ph.D.

Graduate work in education has as a primary function the preparation of
instructors and administrative officers for elementary schools, secondary schools,
and departments of education in colleges and universities. For such preparation
a thorough knowledge of the subject matter to be taught is basic. In addition, it
is essential that teachers not only have a complete understanding of the philos-
ophy of education and methods of instruction but also that they attain skill
in the collection and interpretation of data necessary for the adaptation of
acquired knowledge and skills to specific community situations and to individual
differences among pupils.
Research is carried on in the fields of elementary and secondary education, counseling and guidance, special education, supervision and administration, curriculum, and measurement.

Programs leading to the following degrees are offered: Master of Arts, Master of Education, Doctor of Philosophy, and Doctor of Education. The requirements for each of these degrees are discussed elsewhere in this catalogue. Students electing a major in education must demonstrate on the written examination for the master's degree proficiency in the general field and also in one of the following areas: administration, secondary education, elementary education, guidance, kindergarten-primary education, school library science, special education, statistics, tests and measurements, history and philosophy of education, and educational psychology.

Either the major or minor for the Master of Education degree must be selected from one of the following fields of education: administration, educational psychology, elementary education, guidance, library science, secondary education, special education, student personnel. Both major and minor may be selected from this list. For students who plan to pursue a career of classroom teaching in the secondary schools, however, it is recommended that the major be chosen from a subject matter teaching field.

The following teaching fields are acceptable for either major or minor (but not for both) in fulfilling the requirements for the Master of Education degree: agriculture, art, biology, business education, chemistry, drama, English, French, government, history, home economics, Latin, mathematics, music, physical education—men, physical education—women, physics, secretarial studies, Spanish, speech.

Other fields may be used as major or minor areas upon the recommendation of the dean of the College of Education with the approval of the dean of the Graduate College.

203. Introduction to the Study of Exceptional Children (3) I Hunt
The fundamentals of special education for the classroom teacher. An overview of the incidence, characteristics, and problems of various types of exceptional children.

204. Methods of Teaching the Mentally Retarded (3) II 1959-60 Hunt
Organization of instructional materials and actual construction of plans for teaching mentally-limited children. Basic theories and techniques of teaching the retarded child will be discussed, evaluated, and applied. P, 151 and 203.

209. Principles of Vocational Education (2) II Cline
The social and economic values of vocational education; federal laws, state policies and administration; theories and principles with special reference to programs in the secondary school. Required of those preparing to teach agriculture and home economics.

211. History of Education (3) I Staff
A general survey of the educational system of the leading foreign nations and an evaluation of modern tendencies.

212. History of Education in the United States (3) II Staff
The development of our educational system from colonial foundations to the present.

217. Visual and Auditory Aids in Teaching (3) I, II Klein
Use and management of motion pictures, stereoscopes, slides, charts, radio programs, blackboard techniques; actual instruction in the use of equipment. P, 151, 221, 225, 226, 227 or 234 recommended.

218. Principles of Adult Education (2) II 1959-60 Rhodes

219. Newer Methods of Teaching Reading (3) I 1960-61 Crowder

221. The Elementary School Curriculum (3) I, II Wetzler
A study of the purpose, organization, materials, and content of the curriculum of the modern elementary school. P, 151 or CR.
The Teaching of Reading and the Language Arts (3) I, II
A basic course in elementary curriculum and methods involving the function, organization of materials, and methods of teaching reading and the language arts of spelling, handwriting, speaking, and written communication. P, 151 or CR.

The Teaching of Arithmetic (3) I, II
A basic course in elementary curriculum and methods involving the functions, organization of materials, and methods of teaching arithmetic. P, 151 or CR.

The Teaching of Social Studies and Science (3) I, II
A basic course in elementary curriculum and methods involving the functions, organization of materials, and methods of teaching the social studies and the elementary sciences. P, 151 or CR.

Modern Mathematics in the Secondary School (3) II
The contemporary approach to the teaching of algebra, geometry, and senior mathematics in the high school. Included are the concepts of sets, relations, and functions as a basis for the development of elementary algebra; principles of logic in geometry; and new topics suitable for the superior student. Emphasis is on both subject matter from the modern point of view and method.

The High School as an Institution (3) I, II
Historical development of the high school; aims, functions, and outcomes; the curriculum; relation to other divisions of the school system. P, 3 units in education.

General High School Methods (3) I, II
Teaching techniques based on principles of educational psychology. P, 151, 231 or CR.

Principles and Techniques of Guidance (3) I, II
Introductory course for those who expect to specialize in student guidance or for the teacher to whom some functions of guidance are assigned. P, 231, Psychology 1a.

Counseling Techniques (3) I
Methods and techniques of studying the individual student; collation and interpretation of counseling data and its application to the solution of individual problems.

Occupational and Educational Information (2) II
Study of occupational and educational opportunities of youth and sources of information relating thereto; methods of organizing and filing informational materials; disseminating occupational and educational information in guidance programs. P, 240 or CR.

Testing Instruments for School Counselors (3) I
Study, analysis, and evaluation of standardized tests used in counseling; quantitative aspects of the guidance program; use of results of specific tests. P, 257. Psychology 250 recommended. Fee, $2.

Elementary-School Guidance (3) I 1959-60
Principles and practices of guidance as they apply to the elementary school. P, 9 units in education, including 151.

Group Techniques in Guidance (2) I 1959-60
A study of group techniques, their application in guidance, and the interrelationship of group and individual approaches in the guidance program. P, 240 or CR.

Introduction to Student Personnel Work in Higher Education (3) I
Survey of student personnel programs in various types of institutions of higher learning; the nature and characteristics of the college student and the role of the student personnel program in meeting student needs and problems. P, senior standing.

Counseling College Students (3) II
Principles and techniques of counseling and their application to the work of the student personnel administrator. P, 246 or CR.

Student Life and Activities (2) I 1960-61
The objectives of the student life and activities programs of representative colleges, with emphasis on organization, values, and outcomes, and the role of the personnel administrator therein. P, 246 or CR.

Mental Hygiene (3) I, II
The principles of mental hygiene and their application to personal and social needs. P, 151.
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>252.</td>
<td>Psychology of Elementary Education (2) I 1959-60</td>
<td>Merritt</td>
<td>151</td>
<td>Application of the principles of psychology and of the laws of learning to the several subjects of the curriculum. P, 151, Psychology 1a.</td>
</tr>
<tr>
<td>254.</td>
<td>Statistical Methods in Education (3) I, II</td>
<td>Merritt</td>
<td>151, 251</td>
<td>Elementary methods of dealing quantitatively with school data and data resulting from experimental investigations. P, 9 units in education or psychology.</td>
</tr>
<tr>
<td>256.</td>
<td>The Education of Gifted Children (3) I 1959-60</td>
<td>Hunt</td>
<td>151</td>
<td>Application of the principles presented by the gifted child to the total program of the classroom and of the authentic activities of the gifted child. Baseline theories and techniques of teaching the gifted child will be discussed, evaluated, and applied.</td>
</tr>
<tr>
<td>257.</td>
<td>Educational Tests and Measurements (3) I, II</td>
<td>Merritt-Haberland</td>
<td>151</td>
<td>The principles underlying the making and using of informal objective examinations; practice in making and scoring such examinations; surveys of standard tests in the respective fields. P, 151. Fee, $1.50.</td>
</tr>
<tr>
<td>259.</td>
<td>Chronological Growth and Development of the Child (3) I, II</td>
<td>Rhodes</td>
<td>151, 251</td>
<td>The nature of growth; the genetic and physiological bases of growth; the measurement of physical growth; the assessment of progress in physical growth; skeletal and dental growth; the relation between physical growth and behavior in the child.</td>
</tr>
<tr>
<td>261.</td>
<td>Public Relations for Teachers and Administrators (3) II</td>
<td>Johnston</td>
<td>151</td>
<td>The purposes, necessary organization, agencies, and criteria of good public relations; designed to develop the knowledge and techniques necessary for an effective program of public relations. P, 6 units in education.</td>
</tr>
<tr>
<td>276.</td>
<td>The Teaching of Reading and Language Arts in the</td>
<td>Syverson</td>
<td>151</td>
<td>A basic course in kindergarten and early elementary curriculum and methods involving techniques and materials for the introduction of reading, spelling, handwriting, speaking, and written communication at the kindergarten-primary level. P, 151.</td>
</tr>
<tr>
<td>277.</td>
<td>Theories and Methods of Play Education (3) I, II</td>
<td>Syverson</td>
<td>151</td>
<td>This course will present a child-oriented philosophy of play education. It will include concrete suggestions for play experiences, together with new materials for teacher and child use. Its scope will include a developmental program through the early elementary grades. P, 151.</td>
</tr>
<tr>
<td>278.</td>
<td>Construction Activities in the Kindergarten-Primary School (2) I, II</td>
<td>Syverson</td>
<td>151</td>
<td>The ways in which materials such as clay, wood, cloth, paper, and paint may be used to correlate the basic subjects in the curriculum of the kindergarten and primary grades. P, 151.</td>
</tr>
<tr>
<td>301.</td>
<td>Current Problems in Education (2) II</td>
<td>Merritt</td>
<td>151</td>
<td>A systematic study of the problems found in current educational literature, research studies, school reports, and similar material. Required of all graduate students having education as a major or minor.</td>
</tr>
<tr>
<td>306.</td>
<td>Comparative Education (3) II</td>
<td>Kelley</td>
<td>151</td>
<td>A study of national systems of education and the development of underlying philosophies and practices. Contemporary movements in the educational systems of western European countries with special reference to similar movements in the United States and certain Latin-American countries.</td>
</tr>
<tr>
<td>310.</td>
<td>Philosophy of Education (3) II</td>
<td>Kelley</td>
<td>151</td>
<td>Function of education in a democracy; survey of educational thought and theories; determination of educational objectives.</td>
</tr>
<tr>
<td>314.</td>
<td>Arizona State School System and School Law (3) II</td>
<td>Larson</td>
<td>151</td>
<td>Public education in Arizona; the code relating to schools and a comparison of this code with other state codes and ideal codes.</td>
</tr>
</tbody>
</table>
319. Problems in Special Education (2) II 1960-61
Smith
A seminar approach to the evaluation of recent research and literature in the field of special education. Reports, lectures, and discussions of research. P, 15 hours in special education and related graduate course work.

320. Science Curriculum in
The Elementary School (3) I 1960-61
Blecha
Review of trends in the science curriculum of the elementary school with special reference to selection of content, grade placement of concepts and activities, methods of teaching, needed equipment, and community resources. The course is designed primarily for in-service public-school personnel.

321. Remedial Techniques in Teaching (2) I 1959-60
Haberland
Designed to aid teachers in recognizing learning difficulties and discovering their courses; ways and means of correcting different types of difficulty at all grade levels. Demonstrations where possible.

322. Reading Clinic: Remedial Techniques (3) II 1959-60
Haberland
Practical experience in dealing with problems in remedial reading; laboratory experience in diagnostic reading tests; clinical practice and remedial reading techniques applicable to individual or group needs; actual practice in remedial work. Education 321 is recommended as a prerequisite or a concurrent course.

323. Constructing the Elementary-School Curriculum (3) I
Wetzler
The elementary-school curriculum and its relationships; basic theories and techniques of curriculum construction discussed, evaluated, and applied.

324. Problems in Elementary Education (2) II 1959-60
Wetzler
Review of research literature in elementary education with respect to specific in-service problems of teachers, supervisors, and administrators in elementary schools. Individual or group investigations related to school practices. Laboratory to be arranged. P, 6 graduate hours in elementary education.

325. Communication Skills in the
Elementary School (3) I 1959-60
Syverson
Review of trends in the teaching of communication skills of reading, speaking, listening and writing in the elementary-school curriculum. Both action-research and reviews of the research literature with respect to these skills will be emphasized. The course is designed primarily for in-service public-school personnel who are working toward advanced degrees.

326. Social Studies Curriculum in the Elementary School (3) II 1960-61
Crowder
Review of trends in the social studies curriculum of the elementary school with special reference to selection of content, grade placement of concepts and activities, methods of teaching, needed equipment, and community resources. The course is designed primarily for in-service public-school personnel.

327. Elementary-School Administration and Supervision (3) II
Wetzler
The administrative and supervisory problems of the principal of an elementary school or of a small school system. Special emphasis will be placed on teacher participation in planning and administering the educational program.

328. Observation and Study of Exceptional Children (3) I 1960-61
Smith
A course designed to study specific types of exceptional children, their physical limitations, causes and effects, personality factors, psychological implications, and specific educational approaches to their individual problems. Field trips and class observation of various types of exceptional children will be arranged. P, 203.

329. Investigations in Elementary Education (2) II 1959-60
Wetzler
A critical study and evaluation of the investigations and experimental evidence basic to the aims and instructional practices of the elementary school. P, 9 units in education.

330. Extra-Classroom Activities (3) I 1960-61
Staff
The purposes of extra-classroom activities; techniques of administration.

331. The Teaching of English Composition (3) II
Muir
(Identical with English 334)

332. High-School Administration (3) II
Crowell
The problems of organization and administration of the modern high school.

333. Secondary-School Supervision (3) I
Staff
A comprehensive treatment of the organization used, the relationships involved, and the techniques developed for the effective supervision of modern high-school instruction.
338. Curriculum Construction (3) I  
McCann  
The curriculum and its relationships; basic theories and techniques of curriculum construction discussed, evaluated, and applied. P, 231.

339. Investigations in Secondary Education (2) II 1960-61  
Letson  
A critical study and evaluation of the investigations and experimental evidence underlying the aims and instructional practices of the various subject-matter fields of the secondary school. P, 9 units in education.

341. Directed Application in Guidance (3) II  
Danielson  
Actual practice under supervision in applying the principles, techniques, and tools studied in the guidance program. P, 240, 241, 243.

343. Organization and Administration of Guidance Programs (2) II  
Danielson  
An analysis and evaluation of the administrative organization for guidance and of the techniques for counseling of pupils.

344. Problems in Guidance (2) II 1960-61  
Danielson  

348. Organization and Administration of Student Personnel Programs in Higher Education (2) II 1960-61  
Staff  
Principles of organization and administration; comparative organizational structures as related to institutional needs. P, 246.

351. Advanced Educational Psychology. Learning and Instruction (2) II 1960-61  
Merritt  
An intensive study of the learning process, including such topics as principles of learning, transfer of training, individual differences in learning ability, and the application of these to instructional situations. P, 151, Psychology 1a and a total of 10 hours in education.

354. Advanced Statistical Methods in Education (3) II 1959-60  
Merritt  
Further methods of dealing quantitatively with educational data. Required of all doctoral students in education. P, 254 or equivalent.

356. Field Practices in Teaching Exceptional Children (3 to 6) I, II  
Hunt  
Directed teaching and remedial practices in a public school, special school, or institution. This course follows in close sequence the class work in special education. P, 15 hours in special education and related graduate course work.

357. Test Construction and Theory (3) II 1959-60  
Merritt  
The major topics considered include the functions of measurement in education, the construction of achievement tests and the theory of measurement. P, 151, 254, 257.

358. Individual Diagnostic Techniques in Education (3) I  
Haberland  
Practices in diagnostic testing, applied to the improvement of teaching and to the correction of learning difficulties of exceptional children. P, 151, 240, and 257.

360. General School Admission (3) I  
McCann  
The organization, administration, and supervision of city and town school systems.

364. Problems in School Administration (2) II 1959-60  
McCann  
Review of current literature in school administration. Individual or group investigations related to school administration. P, 326, 336, or 360.

370. Personnel Problems in School Administration (2) I 1959-60  
Johnston

371. School Finance (3) II  
Larson  
Sources and distribution of school funds; accounting and reports.

373. Planning and Maintenance of School Buildings (3) II  
Gavlak  
A comprehensive treatment of the problems involved in the planning, construction, and maintenance of school buildings. An opportunity will be afforded to visit and evaluate some of the newer and more adequate school buildings. P, 12 hours in education.

375. Legal Problems in Education (3) I 1960-61  
McCann  
The analysis of educational problems as influenced by legal principles and the case law; effect of statutory and case law upon school policy decisions. P, Education 314 or 9 hours in school administration, and teaching experience.
376. Supervision: Its Organization and Administration (3) II 1960-61 Staff Qualifications and preparation of supervisors; essential activities in supervision; organization and administration.

390. Techniques in Education Research (3) I Merritt Required as part of the graduate major or minor in education. Open to seniors.

399. Seminar (0) II Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 4) I, II

400. Research (2 to 4) I, II

410. Thesis (4) I, II Maximum total credit permitted, 4 units units

420. Dissertation (1 to 9) I, II

SCHOOL LIBRARY SCIENCE

The North Central Association of Colleges and Secondary Schools, in which many Arizona high schools hold membership, requires that secondary school librarians have completed a minimum of 15 semester hours in library science.

201. Literature for Children (3) I, II Bentz-Saltus The history and development of children’s literature with emphasis throughout on standards of evaluation and reading interest. Reading and analysis of books, particularly modern publications, for student interest, ability, and need, up to the junior-high-school level. P, Education 151, and 6 units in English or American literature. Fee, $2.

202. Library Materials For Elementary Schools (3) II Saltus Selection and evaluation of books and other materials for elementary schools with special emphasis on those which meet curricular needs and interests, and which represent various levels of difficulty. Also ways of stimulating their use. P, 201 and Education 151.

280. Reference Service in the School Library (3) I Bentz The purpose of this course is to acquaint students with the periodical indexes, and bibliographies, encyclopedias, and other reference aids most used in elementary and secondary-school libraries. P, Education 151.

281. Library Administration and Organization (3) II Bentz The functions, activities, organization, and management of the library, particularly the school library, budgeting, equipment, and personnel; the contributions of non-library officials, school administrators, teachers, etc., to the successful operation of the library. P, Education 151.

282. Organization, Cataloguing, and Classification of Materials (3) I Saltus Purpose and principles of cataloguing and classification. The card catalogue, shelf list, filing, vertical files. Organization of materials for use, particularly in school libraries; weeding, maintenance, etc. P, Education 151.


284. Library Materials for Young People (3) II Bentz Selection and evaluation of materials to supplement the junior- and senior-high-school curriculum, particularly in the fields of science and social science, including vocational guidance. Special problems of selection, bibliographies, reading lists. P, 6 hours in education or psychology.

285. Literature for Adolescents (3) II Bentz Books, periodicals, and audio-visual materials of interest to students in junior and senior high school, with emphasis on books and reading for recreation, pleasure and developmental needs. Detailed study of selection aids for various types of materials. Reading guidance for average, retarded, and advanced students. P, 6 hours in education or psychology.
286. Oral Presentation of Children's Literature (2) II  
Principles and techniques of story-telling and of reading aloud to children. Includes selection of stories for different age groups, desirable and undesirable adaptations, presentation of picture stories; practice in reading and telling stories and in planning the story hour. P, 201.

299. Special Problems (1 to 4) I, II  
Staff

Education 217. Visual and Auditory Aids in Teaching (3) II  
Klein  
This course may be counted as credit in the field of library science.

ELECTRICAL ENGINEERING

Professors Paul E. Russell, Ph.D., Head, Stewart Becker, Ph.D., James C. Clark, M.E.E., Walter H. Evans, Ph.D., Charles R. Hausenbauer, Ph.D., Robert A. Hessemer, Ph.D., Granino A. Korn, Ph.D., Thomas L. Martin, Jr., Ph.D., Leander W. Matsch, M.S.E.E., Harry E. Stewart, M.S.E.E., Donald C. Stinson, Ph.D., Robert A. Walker, Ph.D., Ned Wilde, M.S.

Associate Professors John R. Featherston, M.S., Gordon M. Russell, M.S.E.E.

Assistant Professor Walter J. Mearls, M.S.

The Department of Electrical Engineering is equipped adequately for the conduct of research in electronics, servomechanisms, analog and digital computers, circuits, microwaves, and power. Complete data processing services of an IBM 650 are available through the Numerical Analysis Laboratory. Also available is the 100 KW reactor in the Nuclear Engineering Department.

The following advanced degrees are available in electrical engineering:

The Degree of Master of Science.—Not fewer than 30 units of graduate work, including a thesis, are required for this degree. At least 15 units of the course work must be in electrical engineering, not including the thesis. Of these 45 units, only three units of 200 numbered courses are permitted.

The Degree of Master of Electrical Engineering.—This degree is intended for those enrolled in evening and off-campus programs. On-campus daytime students may not work toward this degree. Detailed requirements are given on page 39.

The Degree of Doctor of Philosophy.—The requirements for this degree are given on page 42.

228. Advanced Circuit Theory (3) I, II  
Hausenbauer  
Advanced topics in the Laplace and Fourier transform and pole-zero methods; treatment of frequency selective networks and elementary synthesis procedures. P, 124, CR 229.

229. Advanced Circuits Laboratory (1) I  
Staff  
Experimental aspect of 228. P, 228 or CR. Fee, $5.

240. Theory of Automatic Control (3) I, II  
Hausenbauer-Weaver  
Theory and analysis of closed loop systems and control applications. P, 124, 162.

241. Automatic Control Laboratory (1) I, II  
Staff  
Illustrating 240. P, 240 or CR. Fee, $5.

254. Modulation and Coding (3) I, II  
G. Russell  
Theory and techniques associated with the preparation of information for transmission and reception; modulation, encoding and de-coding processes; information content, band-width, channel capacity, and signal-to-noise considerations in information systems; emphasis upon time and frequency multiplexing. P, 156 and CR 255.

255. Modulation and Coding Laboratory (1) I, II  
Staff  
264. Power System Engineering (3) II
   Fundamental analysis of the power system under steady state and fault conditions. P, 162, CR 265.

265. Electrical Power Laboratory (1) II

272. Electronic Analog Computers (3) I, II
   Application and basic design of analog computers, with emphasis on d-c analog computers. Computing elements and scale factors. Applications to dynamics, control systems, and aircraft flight equations. P, Senior standing in EE, CR 273.

273. Basic Analog-Computer Laboratory (1) I, II

274. Elements of Machine Logic (3) II
   Featherston This course treats the logical design of computers and computer systems. No background in electronics is pre-supposed. Boolean algebra, Vich diagrams, difference-equation approach to memory elements, Huffman-Moore models of digital systems, and techniques for design of complete systems involving computers are among the topics discussed. P, Math. 79b.

280. Electromagnetic Engineering (3) II
   Hessemer-Stewart High frequency transmission lines, waveguides, waveguide components, antennas, horns, and parabolas. P, 180 or CR. Fee, $5.

281. Electromagnetic Engineering Laboratory (1) II
   Illustrating 280. P, 280 or CR. Fee, $5.

310. Operational Methods of Circuit Analysis (3) I, II
   Rogers A presentation of the elements of functions of a complex variable followed by application of Fourier transform and Laplace transform techniques to the problem of signal transmission through lumped and distributed parameter systems. P, Math. 180.

322. Network Synthesis II (3) II
   Rogers A continuation of the development of synthesis methods; synthesis of two-terminal-pair networks is developed. The approximation problem is treated in some detail. Application of the material to wide-band amplifiers and feedback systems is discussed. P, 320.

335. Introduction to Random Processes and Noise (3) I

336. Reliability in Electronic Systems (3) II

338. Methods of Communication Theory and Detection Theory (3) I, II

340. Synthesis of Control Systems I (3) I

342. Sampled-Data and Digital Control Systems (3) II

344. Statistical and Nonlinear Control Systems (3) II
   Weaver Application of statistical techniques to linear control systems subjected to random disturbances. Study of nonlinear control systems with emphasis on describing function and phase plane analysis. Analog computation techniques as applied to statistical and nonlinear problems. P, 240, 310, Math. 291a.
354. Video and Filter Amplifiers (3) I  Walker
Design of wide band and fast amplifiers using pentodes and transistors; stagger tuning, distributed amplifiers, feedback, and noise. P, 310 or CR.

355. Pulse and Logic Circuits (3) II  Walker
Wave shaping, trigger, and computing circuits and non-sinusoidal oscillators using vacuum tubes and semiconductor devices. P, 310.

356. Magnetic Amplifiers (3) I, II  Staff
Theory of magnetic amplifiers with emphasis on basic types; study of practical circuits and their application in servo systems, as computer elements and control devices.

357. Transistor Electronics (3) I, II  Walker
Physical theory of the p-n junction and the transistor; equivalent circuits for small signal and switching applications; basic transistor circuitry.

358. Transmission of Electric Power (3) II  Matsch
Structure of power and distribution of systems. Characteristics and steady-state performance of power-transmission lines. Regulation of voltage and frequency in the power system.

359. Symmetrical Components (3) I  Matsch
Analysis of unbalanced polyphase power systems; sequence impedances and networks; fault calculations. Application to problems of grounding, relaying, and unbalanced operation of apparatus.

360. Protective Relaying (3) II  Matsch
System protection by relays against abnormal conditions; steady-state and transient conditions; single and multiple faults. P, 366.

361. Advanced Alternating-Current Machinery (3) I  Matsch
Harmonic analysis of the magnetic density in the air gap, and the effect of harmonics on emf, torque, and vibration; transient conditions following sudden load changes; stability criteria; unbalanced operation.

362. Power System Stability (3) II  Matsch
Steady state and transient stability of power systems; power limits; high speed relaying; rapid operation of circuit breakers; action and effects of governors, excitation systems, and damper windings. P, 366.

363. Analog Computation (3) I, II  Korn

364. Microwave Fundamentals (3) I  Hessemer
Developments and application of electromagnetic-field theory to the analysis of high-frequency circuits, wave propagation, and reflection of various media including waveguides. P, 180.

365. Microwave Tubes (3) II  Hessemer
Study of the fundamental concepts applicable to klystrons, magnetrons, traveling wave tubes, and other related devices. P, 580.

366. Antenna Theory (3) I, II  Hessemer
Study of the physical principles underlying antenna behavior, design, and experimentation. The basic principles applied to antennas of all frequencies. P, 380.

367. Microwave Networks (3) II  Stinson
A study of the network theory, including the general theorems and the methods of analysis, as applied to microwave waveguide, cavities, and discontinuities. P, 380.

INDIVIDUAL STUDIES

299. Special Problems (2 to 5) I, II

400. Research (2 to 5) I, II
ENGINEERING

Work leading to master's degree is offered with majors in aero-space, agricultural, chemical, civil, electrical, mechanical, metallurgical, mining, and nuclear engineering, and in engineering mechanics and physical metallurgy. Adequate facilities for research are available. A minimum of 30 units of properly selected work is required for this degree. In all fields except agricultural engineering, a minimum of 15 units must be selected from the courses listed under the major department; while in agricultural engineering the courses listed in this field (page 86) may be combined with work in civil and mechanical engineering to make up the 15-unit minimum. In all fields, supporting courses may be selected from appropriate related areas of study with the approval of the major department.

The degree of Doctor of Philosophy is offered in aero-space, civil, electrical and mechanical engineering, in engineering mechanics and in metallurgy. The general requirements for this degree are set forth on page 42.

For more detailed information concerning graduate programs in engineering see the following department headings:

- Agricultural Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Mining and Metallurgical Engineering
- Nuclear Engineering
- Numerical Analysis
- Systems Engineering

ENGINEERING MECHANICS

(See Civil Engineering)

ENGLISH

Professors Desmond S. Powell, Ph.D., Head, Albert F. Gegenheimer, Ph.D., Francis Gillmor, Dra.Ltrs., Marie P. Hamilton, Ph.D., A. Laurence Muir, Ph.D., Inez Thrift, Ph.D., William J. Tucker, Ph.D.

Associate Professors William F. Irmscher, Ph.D., Florence H. Morgan, Ph.D.

Assistant Professors Dorothy Fuller, M.A., Jack W. Huggins, M.A., Carl F. Keppler, Ph.D., Carl H. Ketcham, Ph.D., Robert W. Ramsey, M.A., Alsie F. Schulman, M.A., Oliver F. Sigworth, Ph.D.

Instructors H. Christian Kiefer, M.A., Patrick J. McCarthy, M.A.

Students wishing to work for the degree of Master of Arts in English must have completed the undergraduate major in English or an acceptable equivalent. Such students are usually expected to have studied a foreign language for at least two years. The degree is conferred on those who have completed 26 or 27 hours of course work with an average grade of 2.0, completed a thesis, and passed an oral examination on the thesis. A qualifying examination for candidacy may be required at the discretion of the department. The courses may be entirely in English or partly in an allied field. They must include Old English, Chaucer, History of the English Language, Bibliography, and Principles and Practice of Literary Criticism, provided such courses have not been taken previously for credit. The thesis may be in the field of the English language, in English literature, in American literature, or in comparative literature.

See page 38 for Master of Education degree major or minor in this department.
210. Advanced Writing (1 to 4) I, II
P, 7 and 101 or 104, or professional experience.

Ramsey

224. Literature of the Southwest (3) II
The last frontier in fact and fiction; the accounts of early travelers, the development of the "Western story," the regional novel. Useful bibliography.

Huggins

225. The Novel in America (3) II 1959-60
A study of the American novel from the colonial period to the twentieth century. Reading of representative novels from the different periods.

Gegenheimer

226a-226b. Survey of English Literature (3-3) Yr.
Required of all majors and teaching minors. 226a is not prerequisite to 226b.

McCarthy-Sigworth-Tucker

227a-227b. The Romantic Movement in English Literature (3-3) Yr.
Ketcham

227a: The rise of revolutionary ideas and literary techniques; Wordsworth, Coleridge, Byron. 227b: Shelley, Keats, Scott, and the minor poets. 227a is not prerequisite to 227b.

228. Victorian Poets (3) I
Tennyson, Browning, and their contemporaries.

Powell

229. Victorian Essayists (3) II
Literary and social aspects of the essay in the Victorian Age: Carlyle, Newman, Arnold, Ruskin, and others.

Powell

230a-230b. The English Novel (3-3) Yr.
230a: The novel from its beginning to the death of Scott, 1832. 230b: Thackeray and Dickens to the present. 230a is not prerequisite to 230b.

McCarthy-Tucker

231a-231b. Shakespeare (3-3) Yr.
Keppler-Kiefer

231a: Introductory course. The life and times of Shakespeare. Rapid reading of representative plays. 231b: A more detailed study of Shakespearean types and themes. 231a is not prerequisite to 231b.

232a-232b. The Development of English Drama (3-3) Yr.
Muir

232a: The drama from its beginning to 1642. 232b: The drama of the Restoration and eighteenth century. 232a is not prerequisite to 232b.

234. Modern Drama (3) II
Irmscher

237a-237b. Chaucer and His Age (3-3) Yr.
Hamilton

237a: The Canterbury Tales, read in Middle English. 237b: Troilus and Cressida, The Legend of Good Women, and other selections, read in Middle English. 237a is not prerequisite to 237b. One semester is required of all graduate majors who do not have undergraduate credit in Chaucer.

239. Milton (3) II 1959-60
Thrift

240. Neoclassicism (3) I
Tucker

Non-dramatic literature of the Restoration and the eighteenth century. Dryden, Pope, Swift, Johnson, and their circles; the pre-Romantics.

242. Contemporary Poetry (3) II
Fuller

The lyric of England and America in the last four decades.

243. Literature, the Arts, and Society in the Eighteenth Century (3) II
Sigworth

Studies in the manifestations of several of the dominant ideas of the age in the arts of eighteenth-century England, the Continent, and America as well as in the literature, particularly of England and France. Lectures designed to integrate individual student research cutting across several conventional areas of study.

244. American Drama (3) II 1960-61
Gegenheimer

The development of drama in the United States from the colonial period to the present time. P, 6 units in American literature or in English and European drama.

250a-250b. The Literature of the Bible (2-2) Yr.
Thrift

The most notable portions of the Bible, with historical and social background.

260. History of the English Language (3) II
Hamilton

Required of all graduate English majors.
285. Types of Folklore (3) II
   Gillmor
   A study of types, including tales, legends, riddles, proverbs, folk songs, children's
   games, and rhymes. Training in methods of collection and analysis. P, 6 units of
   literature and 6 units of related social science.

315. Principles and Practice of Literary Criticism (3) I
   Muir
   The classical background and selected readings in English criticism. Writing of
   critical papers. Required of all graduate English majors.

316. Modern Criticism (3) II
   Kiefer
   Twentieth-century trends in literary criticism. Reading of representative essays.

324. Studies in American Literature (3) I
   Gegenheimer
   P, 1 year of American literature.

331. Studies in Shakespeare (3) II
   Kiefer
   P. 251a-251b or 252a.

334. The Teaching of English Composition (3) II
   Muir
   An introduction to the problems and procedures in composition courses, with emphasis
   on Freshman English and attention to secondary-school courses and to the relation-
   ships between high-school and college English.
   (Identical with Education 334)

338. Old English (3) I
   Hamilton
   The language, with reading of representative prose and poetry. Required of all
   graduate English majors.

340. Studies in the Seventeenth Century (3) I
   Irmscher
   A general view of the period, exclusive of Milton, with selected studies in the central
   figures: Donne, Jonson, Herrick, Herbert, and the religious lyricists; the Cavalier poets;
   the prose of Bacon, Walton, Sir Thomas Browne, and Dryden.

350. Bibliography (2) I
   Gegenheimer
   Aims, methods, and history of literary scholarship; bibliographical tools for the
   study of literature; thesis and form. Required of all graduate English majors.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 3) I, II

410. Thesis (2 to 4) I, II
   Maximum total credit permitted, 4 units

ENTOMOLOGY

Professor Laurence A. Carruth, Ph.D., Head

Associate Professors William L. Nutting, Ph.D., Floyd G. Werner, Ph.D.

Assistant Professors George D. Butler, Jr., Ph.D., James M. Witt, Ph.D.

Lecturer Frank E. Todd, B.S. (U. S. Department of Agriculture)

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The Doctor of Philosophy degree is offered with entomology as a field of specialization under the Plant Science Program (see page 44).

The department maintains teaching laboratories and offices on the University campus, research laboratories at the Campbell Avenue Farm (Tucson), and field laboratories at Phoenix, Mesa, and Yuma. The facilities of these laboratories are available to qualified graduate students and provide exceptional opportunities for individual research in both fundamental and applied branches of entomology. The department maintains a large reference collection of Arizona insects. The University Library contains an excellent working collection of serials and reference books in the field of entomology. In addition to guidance by members of the teaching faculty listed above, opportunities are available for qualified graduate students to work on individual research problems under experienced entomologists engaged in
research for the Agricultural Experiment Station of the University of Arizona or
the United States Department of Agriculture. Fields of entomological research cur-
rently under active investigation by University entomologists and cooperating en-
tomologists on the staff of the United States Department of Agriculture include
taxonomy, biology, physiology, toxicology, apiculture, biological control, and vari-
ous phases of economic entomology, including the study and control of insects af-
fecting alfalfa, cotton, fruits, vegetables, stored products, and certain other crops
and commodities.

Candidates for the degree of Master of Science must have completed at least
one undergraduate course in entomology and, in addition, must have fulfilled the
requirements for an undergraduate major in entomology, zoology, or some other
acceptable field in the biological or agricultural sciences. Candidates should have
completed a broad group of foundation courses in the physical sciences, in the plant
and animal sciences, and in general cultural subjects.

Candidates for the degree of Master of Science are required to complete Ento-
mology 203, 204, 205, and 206, or their equivalents, if such courses have not been
taken on the upper-division undergraduate level. Additional supporting courses in
entomology and related departments may also be required. Qualified students may
enroll for from two to four units of work per semester under Entomology 400—
Research—for special individual studies in phases of entomology not included in
the four courses mentioned above. All candidates for the Master of Science degree
must complete from two to eight units of thesis 410. All graduate students major-
ing in entomology are normally expected to devote at least one summer to actual
field experience in entomology in Arizona.

Acceptable fields of minor study for students majoring in entomology include
agricultural chemistry and soils, agronomy, bacteriology, botany, chemistry, horti-
culture, plant pathology, range management, watershed management, and zoology.
Minor work may be arranged in other departments after individual conferences and
with the approval of the Department of Entomology and the dean of the Graduate
College.

203. Principles of Insect Control (3) I Carruth
Properties, formulation, and application of insecticides; non-chemical control meth-
ods. 2R, 3L, field trips. P, 1. Fee, $10.

204. Insect Morphology (4) I 1960-61 Nutting
A systematic consideration of insect structure as related to function, phylogeny, and
identification; modifications in development and habits peculiar to the insects. 2R, 6L.
P, 1. Fee, $7.

205. Destructive and Useful Insects (4) II Carruth-Werner
Recognition, economic importance, life history, habits, and control of the more im-
portant types of destructive insects, including those of particular interest to the South-
west; recognition and uses of beneficial insects. 2R, 6L, field trips. P, 1. Fee, $10.

206. Taxonomy of Insects (4) I 1959-60 Werner
A comprehensive study of the orders and families of insects and certain related
arthropods with emphasis on the recognition, identification, and biology of groups of
scientific and economic importance; principles of classification; entomological literature.

207. Insect Physiology (3) I 1959-60 Nutting
This course will survey the physiological systems, with a consideration of general
physiological principles as they are illustrated by the insects. Open to students who
satisfy the instructor that they possess an adequate background in biology and chem-
istry. 2R, 3L. P, 1. Fee, $7.

208. Insect Toxicology (3) II 1960-61 Witt
Nature of insecticides, their mode of toxic action, mechanisms of detoxication, and
structure-activity relationships. Insecticide residue problems, bioassay, and insect re-
sistance. P, 203 or Chemistry 140b.

399. Seminar (1) I, II Staff
Special topics and current developments in entomology.
INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 4) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

FRENCH
(See Romance Languages)

GEOCHRONOLOGY

Committee (Graduate)

Professors Herbert D. Rhodes, Ph.D., Chairman, Frederic W. Galbraith, Ph.D. (Geology), Emil W. Haury, Ph.D. (Anthropology), John F. Lance, Ph.D. (Geology-Paleontology)

Associate Professors E. Lendell Cockrum, Ph.D. (Zoology), Paul E. Damon, Ph.D. (Geology-Geochemistry), Edwin B. Kurtz, Ph.D. (Botany), Terah L. Smiley, M.A. (Geochronology) Executive Vice Chairman, Edward N. Wise, Ph.D. (Chemistry)

Geochronology encompasses all methods which can be applied to the dating of terrestrial events, and is, therefore, an interdisciplinary field. Committee members are selected from various departments associated with the program.

Academic work in geochronology is offered on two levels of graduate instruction: as a major on the Master of Science level, and as a minor subject for doctoral candidates with a major in one of the related fields.

Master of Science degree candidates must have as a minimum background an undergraduate major in one of the related fields of anthropology, botany, chemistry, geology, zoology, or a closely related science, which must include eight units each of chemistry, mathematics, and physics. A student intending to pursue studies in archaeology, dendrochronology, geochemistry, geology, paleoclimatology, paleontology, or palynology must present undergraduate preparation appropriate to the field chosen, or undertake such courses without graduate credit. The amount and character of such work will depend on the student's preparation and the particular aspect of geochronology he elects.

The program of study for candidates on the doctoral minor level will be planned with consideration of the requirements of the individual students.

The Geochronology Laboratories offer several elective options in research wherein concentrated studies should be made. Other options not listed may be selected through cooperation with related departments. All candidates must take courses 300 and 301, however.

Research and academic options include the following:

Dendrochronology. — In cooperation with the Laboratory of Tree-Ring Research, which houses one of the most extensive collections of its kind, research in tree-ring chronologies can be carried on. Students selecting this option should have a background in botany, climatology, and meteorology.

Geochemistry. — Research can be pursued in radioactivity-dating techniques such as potassium-argon and radiocarbon. Geochemical courses and research can be pursued through cooperation with the Department of Geology. Students selecting these options should have an appropriate background in chemistry, geology, mathematics, and physics.
Paleoclimatology. — Research in paleoclimatology can be carried on through cooperation with the Department of Meteorology and Climatology. Students selecting this option should have an appropriate background in botany, climatology, geology, mathematics, meteorology, physics, and zoology.

Paleontology. — In cooperation with the Department of Geology, various courses and research activities can be pursued in vertebrate and invertebrate paleontology. Students electing to take this option should have appropriate background courses in geology and zoology.

Palynology. — Studies in fossil pollen and spore extraction and identification can be pursued. The library of modern pollen grains contains many of the major plant species present in the Southwest, and this library is being enlarged constantly. Students selecting this option must have an appropriate background in botany, chemistry, climatology, geology, and mathematics.

In addition to these, other options in the fields of archaeology, geology, geomorphology, and sedimentation can be pursued.

202. Principles of Stratigraphy (3) I (Identical with Geology 202) Staff

209. Introductory Vertebrate Paleontology (3-3) Yr. (Identical with Geology 209) Lance

218a-218b. Scientific Illustration (2 to 4-2 to 4) Yr. (Identical with Zoology 218a-218b) Sayner

221. Physical Climatology (3) II (Identical with Meteorology 221) Sellers

250. Principles of Geomorphology (3) I (Identical with Geology 250) Lance

258. Principles of Geochemistry (3) I (Identical with Geology 258) Damon

275. Cenozoic Mammalian Faunas (3) II (Identical with Geology 275) Lance

295. Dendrochronology (3) I 1960-61 Smiley History and development of tree-ring studies, climate and ring growth, and theory of dendrochronology applied to archaeology, botany, climatology, ecology, forestry, and geology. P, senior standing in related field. (Identical with Anthropology 295)

300. Methods in Geochronology (3) I Smiley-Staff A survey of important methods used in geochronology with special emphasis on those methods applicable in the Southwest.

301. Laboratory Methods in Geochronology (2) II Smiley-Staff A series of controlled laboratory demonstrations in dendrochronology, paleontology, palynology, radiocarbon and potassium-argon dating, and stratigraphy. 1R, 3L. P, 300. Fee, $5.

305. Paleoclimatology (3) II 1960-61 Staff Survey of climatic variations during historic and geologic time; geological and meteorological factors contributing to climatic instability; interrelations between paleoclimatology and other historical sciences. P, Meteorology 71.


320a-320b. Micropaleontology (3-3) Yr. (Identical with Geology 320a-320b) Miller
329. Nuclear Geology (3) II
   (Identical with Geology 329) Damon
330. Advanced Geochemistry (3) II
   (Identical with Geology 330) Damon
331. Pleistocene Biology (2) I 1959-60
   Martin
   Events of the glacial period as they relate to natural sciences, glacial geology, relative
   and absolute dating, pollen stratigraphy, the fossil record, biogeographic theory, and the
365. Isotope Geology (2) I
   (Identical with Geology 365) Damon
370a-370b. Stratigraphic Paleontology (3-3) Yr. 1960-61
   (Identical with Geology 370a-370b) Miller
371a-371b. Advanced Invertebrate Paleontology (4-4) Yr. 1959-60
   (Identical with Geology 371a-371b) Miller
375a-375b. Palynology (3-3) Yr.
   Martin
   375a. Morphology, classification and evolution of pollen and spores. Preparation of
   modern reference slides. Pollen diagrams, their application in paleoecology and the re-
   construction of climatic history. Fee, $5.
   375b. Tertiary, Pleistocene, and archaeological pollen stratigraphy. Laboratory ex-
   traction of various sediments with emphasis on the Southwest. P, graduate standing in
   related field. Fee, $5.
380a-380b. Advanced Stratigraphic Geology (3) Yr.
   (Identical with Geology 380a-380b) Staff
399. Seminar (1) I, II
   (Identical with Geology 399) Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (1 to 4) I, II
410. Thesis (2 to 4) I, II

The courses listed below may be taken for credit in Geochronology when the
emphasis is within the related field. For a description of the courses, see the list-
ing with the individual departments.

ANTHROPOLOGY 307a-307b. Methods in Archaeology (2-2) Yr. Haury
ANTHROPOLOGY 311a-311b. Tree-Ring Dating for
   Archaeologists (3-3) Yr. 1960-61 Bannister

ANTHROPOLOGY 320a. Advanced Field Course in
   Archaeology (6) S Haury-Thompson

BOTANY 202. Plant Anatomy (4) I Phillips
BOTANY 204. Systematic Botany (4) II Mason
BOTANY 242. Methods in Plant Histology (4) II Phillips
BOTANY 266. Plant Geography (2) I Turner

CHEMISTRY 222. Instrumental Methods of Analysis (3) II Wise

CHEMISTRY 280a-280b. Physical Chemistry (3-3) Yr. Chapin-Forster-Keller

CHEMISTRY 281a-281b. Physical Chemistry Laboratory
   (2-2) Yr. Chapin-Forster-Keller

CHEMISTRY 312. Radiochemistry (2) I 1959-60 Wise

GEOLOGY 208. Geology of North America (3) II Staff
GEOLOGY 212s. Field Geology (Summer Camp) (3) DuBois
GEOLOGY 213s. Geologic Mapping (Summer Camp) (3) DuBois
GEOLOGY 216. Petrography (3) I, II DuBois
GEOLOGY 304. Geology of Arizona (2) II Lance
GEOLOGY 308. Advanced Structural Geology (3) I Mayo
GEOLOGY 311. Sedimentary Petrography (3) I Pye
GEOLOGY 314. Clastic Sediments and Sedimentation (3) II 1959-60 Pye
GEOLOGY 323. Geotectonics (3) II  Mays
GEOLOGY 326. Advanced Petrographic Methods (3) II 1959-60  DuBois
GEOLOGY 360. Physics of the Earth (2) II 1960-61  Pye
GEOLOGY 385. Carbonate and other Chemical and Biochemical Sediments (3) II 1960-61  Pye
HORTICULTURE 249. Fundamentals of Tree-Growth (2) I  Kuykendall

GEOLOGY

Professors Frederic W. Galbraith, Ph.D., Head, Bert S. Butler, D.Sc., John W. Harshberger, Ph.D., Willard C. Lacy, Ph.D., John F. Lance, Ph.D., Evans B. Mayo, Ph.D., Willard D. Pye, Ph.D.

Associate Professors John W. Anthony, M.S., Paul E. Damon, Ph.D., Robert L. DuBois, Ph.D., Thomas W. Mitcham, Ph.D., Joseph F. Schreiber, Ph.D.

Assistant Professor Halsey W. Miller, Ph.D.

The Department of Geology offers graduate work leading to the Master of Science and Doctor of Philosophy degrees.

Each student entering graduate work in geology must have credits in undergraduate courses equivalent to those required at the University of Arizona for a Bachelor of Arts or Bachelor of Science degree in geology, or a geological engineering degree. Minimum course requirements consist of 40 units of geology equivalent to Geology 1a-1b, 9, 103, 106, 115, 121, 125, 202, 212s, 213s, 216; and supporting courses must include general and analytical chemistry (11 units), engineering drawing and descriptive geometry (6 units), college algebra and plane trigonometry (5 units), general physics (8 units).

A student beginning his first term of graduate study at the University of Arizona will be required to take on the morning preceding general registration a written placement examination to evaluate his general background in geology. This examination will be used to determine his understanding of basic subjects and to assist in advising him concerning his program. If a student is deficient in any subject, or shows weakness in some particular field, such weakness must be corrected at the earliest possible date.

Master of Science Degree. — For general requirements, see page 35.

Course requirements for the Master of Science degree consist of a minimum of 30 units which may include 4 units of thesis credit. Certain general courses will be required of all graduate students but these will vary according to the field of concentration.

Before a student is permitted to begin a thesis problem he must have attained a score of at least 650 on the Graduate Record Examination in geology. Failure to achieve this score in two attempts will automatically disqualify him from receiving an advanced degree.

Doctor of Philosophy Degree. — For general requirements, see page 42.

Credit requirements for the Doctor of Philosophy degree are the equivalent of two years of graduate study beyond the bachelor’s degree, exclusive of the dissertation which requires the equivalent of a full year’s work. The major must consist of at least 36 units of geology, exclusive of dissertation, except in those cases in which supporting work in mathematics, physics, chemistry, and biology may be included with the consent of the department and the approval of the Graduate Council.

The qualifying examination will consist of the Graduate Record Examination which must be passed with a score of at least 700. Failure to achieve this score in two attempts will automatically disqualify the student from becoming a candidate for the Doctor of Philosophy degree. The student must pass the qualifying examination and both language examinations prior to his written and oral preliminary examination in major and minor fields. The preliminary examination should be taken
toward the end of the second year of graduate work and must be passed prior to
beginning the dissertation.

Students working for advanced degrees may specialize in one or more of the
following fields:

<table>
<thead>
<tr>
<th>Field</th>
<th>Specialization</th>
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<tbody>
<tr>
<td>Economic geology</td>
<td>Geomorphology</td>
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<tr>
<td>Engineering geology</td>
<td>Geophysics</td>
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<td>Groundwater</td>
<td>Mineralogy-crystallography</td>
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<td>Mineral deposits</td>
<td>Paleontology</td>
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<td>Petroleum</td>
<td>Invertebrate</td>
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<td>General Geology</td>
<td>Vertebrate</td>
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<td>Geochemistry</td>
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202. Principles of Stratigraphy (3) I Schreiber
Environments of deposition, facies, correlation, and the interpretation of specific lithotypes. 2R, 3L, which include 2 field trips. P. Fee. $4.

(Identical with Geochronology 202)

205. Industrial Minerals (3) I Lacy-Pye
Mode of occurrence, specifications, uses, and methods of evaluating industrial mineral deposits. 2R, 3L. P. 103. Fee. $2.

206. Engineering Geology (3) I Lacy
Principles of soil and rock mechanics and their relations to geological features influencing design, construction, and maintenance of engineering projects. 2R, 3L, which include one field trip. P, senior standing. Fee, $2.

207. Geological Interpretation of Aerial Photographs (2) I Mitcham
Use of aerial photographs in geologic mapping and in physiographic, structural, and stratigraphic interpretation. 6L. P, 121. Fee, $4.

208. Geology of North America (2) II Schreiber

209. Introductory Vertebrate Paleontology (3) I Lance
Osteology, affinities, and history of the vertebrates. 2R, 3L, which include 2 field trips. 1b or Zoology 1a. Fee, $5.

(Identical with Geochronology 209)

210. Mining Geology (3) II Lacy
The application of geology to exploitation, valuation, and development of mineral deposits, including underground geologic mapping and the preparation of maps, structure sections, and reports. 1R, 6L. Laboratory comprises field trip every Saturday. P, 106, 121. Fee, $15.

212s. Field Geology (Summer Camp) (3) † DuBois
Field methods of geologic mapping and the preparation of geologic reports. Laboratory comprises daily field work. Required of geological engineers and geology majors. 45L, 3 briefing sessions. P. 106, 121. Fee, $100. Students required to report to camp or to nearest rail or bus station.

213s. Geologic Mapping (Summer Camp) (3) † DuBois
Field methods of geologic mapping and the preparation of geologic reports. Laboratory comprises daily field work and overnight trips to Canyon de Chelly, Grand Canyon, and Buell Park. Required of geological engineers and geology majors. 45L, 3 briefing sessions. P, 212s. Fee, $100. Students required to report to camp or to nearest rail or bus station.

216. Petrography (3) I, II DuBois
Petrographic studies of rocks in thin sections. 2R, 3L. P, 115. Fee, $5.

218a-218b. Scientific Illustration (2 to 4-2 to 4) Yr. Sayner
(Identical with Zoology 218a-218b)

219. Geophysics I (3) I Pye
A survey of geophysical techniques applied to the location and evaluation of petroleum or mineral deposits; seismic, gravimetric, magnetic, electrical, electromagnetic, and radioactivity instruments, methods, and interpretation. P, Physics 11, 15, 20 or equivalents. 2R, 3L. Fee, $2.

220. Geophysics II (3) II 1959-60, 1961 Pye
A study of the theory of gravimetric, magnetic, electric, seismic, radioactive, and other geophysical techniques; a study of new techniques being developed and case histories of oil and mineral deposits discovered by geophysical techniques. P, 219.

† Graduate credit permitted if student has completed 6 units of field geology.
221. Structures of Sedimentary Rocks (3) II
Mayo
Primary structures of sediments and their subsequent modifications. Practice in threedimensional visualization, with the aid of descriptive geometry, and in map interpretation. 2R, 3L, P, 121.

222. Petroleum Geology (3) I
Pye
Principles and methods of petroleum geology with practical exercises. 2R, 3L, P, 1b, 9, 121. Fee, $4.

225. Crystal Measurement and Introduction to X-Ray Crystallography (2 or 3) I
Anthony
Theory and practice of crystal measurement and x-ray diffraction with emphasis on the powder method as applied to the identification of crystalline solids. 2R, 3L. Fee, $5. (Metallurgy students register for 2 units and attend second two-thirds of course; geology students register for 3 units).

228. Ore and Petroleum Discovery (3) I, II
Lacy-Mitcham-Pye
Guides, techniques, and philosophies leading to location and delimitation of ore bodies and oil fields. Two field trips. P, 103. Fee, $4.

229. Atomic Structure of Minerals (2) II
Anthony
Physical and chemical properties of crystalline solids examined with regard to their atomic structures; special emphasis on minerals. P, 9, Chemistry 20a.

235. Geology of Ground Water (3) II
Harshbarger
Geology and hydrologic factors controlling occurrence and development of ground water. 3R. Two field trips. Fee, $4.

238. Prospect Valuation and Development (3) II
Lacy-Mitcham-Pye
Application of the principles of geology to the examination, testing, appraisal, and development of mineral and petroleum prospects. P, 222 or 228.

250. Principles of Geomorphology (3) I
Lance
Classic and modern concepts of geomorphology with emphasis on applications to field and structural geology and geochronology. P, 9, 121.

258. Principles of Geochemistry (3) I
Damon
An introductory course in the chemistry of the earth. Survey of the origin, structure, and composition of the earth and the distribution and migration of the chemical elements in nature. P, 1a-1b, Phys. 11, 15, 20 or equivalents; Chemistry 2a-2b.

275. Cenozoic Mammalian Faunas (3) II
Lance
Evolution of mammalian orders, continental Cenozoic stratigraphy of North America, and origin and extinction of Pleistocene fauna. 2R, 3L, which include 2 field trips. P, 1b or Zoology 1a. Fee, $5.

303. Base Metal Deposits (3) I
Lacy
Major deposits of copper, lead, zinc, iron, and other base metals. 2R, 3L. One field trip. Fee, $4.

304. Geology of Arizona (2) II
Lance

307. Exploration Photogeology (2) II
Mitcham
Application of photogeology techniques, determining structural situations and rock alteration, in delimiting ore targets. 6L. P, 207, 228. Fee, $4.

308. Advanced Structural Geology (3) I
Mayo
Major tectonic features. Three-dimensional representation and fault problems. 2R, 3L, which include 2 field trips. Fee, $4.

310. Igneous Petrography (3) II 1960-61
DuBois
The petrology of igneous rocks with selected petrographic and petrogenetic studies. 2R, 3L, P, 216. Fee, $2.

311. Advanced Determinative Mineralogy (3) I
Anthony
Consideration of chemical and instrumental methods in mineral identification and their application in mineral paragenetic studies. 1R, 6L. Fee, $5.

312. Sedimentary Petrography (3) I
Schreiber
313. Granite Tectonics (3) I
   Mayo
   Application of mechanical principles to structural problems in igneous and granitic rocks. Construction of tectonic maps and structure sections. 2R, 3L, which include 2 field trips. Fee, $4.

314. Sedimentation (3) II 1959-60
   Schreiber
   Sources of clastic material, agents of transportation, environments of deposition of clastic sediments, and post-depositional changes; laboratory techniques of analysis of coarse and fine clastics including clays; statistical analysis of sediments. 2R, 3L, which include 2 field trips. P, 312, CR Mach. 191. Fee, $5.

315. X-Ray Crystallography (3) II
   Anthony
   Theory of space group symmetry and its determination through single crystal x-ray diffraction techniques using rotation and Weissenberg cameras. 1R, 6L. Fee, $5.

320a-320b. MicroPaleontology (3-3) Yr.
   Miller
   Preparation, identification, and classification of microfossils with emphasis on Foraminifera, Ostracoda, and Conodonts. 1R, 6L. 320a is not prerequisite to 320b. Fee, $2. (Identical with Geochronology 320a-320b)

322a,b,c,d,e,f. Advanced Petroleum Geology (3) II
   Pye
   This course will cover advanced topics in petroleum geology and will be offered as:
   (a) Petroleum fields of the world
   (b) Secondary recovery of oil
   (c) Geological aspects of production and reservoir engineering
   (d) Advanced exploration techniques
   (e) Borehole logging
   (f) Current problems of petroleum geology

323. Geotectonics (3) II
   Mayo

324. Preparation of Geologic Reports (2) I, II
   Lance
   Planning and writing geologic reports; preparation of illustrations.

326. Advanced Petrographic Methods (3) II 1959-60
   DuBois
   Course covers universal stage techniques, integrating stage methods, double variation determinations, and various staining and etch procedures. 1R, 6L. Fee, $5.

327. Metamorphic Petrography (3) I
   DuBois
   The petrology of metamorphic rocks with selected petrographic and petrogenetic studies. 2R, 3L. P, 216. Fee, $5.

329. Nuclear Geology (3) II
   Damon
   Systematic study of nuclear processes occurring in nature which are of interest to the geologist. Particular attention will be given to geochronological applications. Techniques of interest to industry such as radiometric prospecting, radioisotope tracing, and activation analysis also will be discussed.
   (Identical with Geochronology 329)

330. Advanced Geochemistry (3) II
   Damon
   An advanced course in the systematic geochemistry of individual elements with applications to basic and applied research problems. P, 258 or 229 and Chemistry 284b.
   (Identical with Geochronology 330)

331. Volcano Tectonics (2) II
   Mayo
   Relation of volcanism to orogeny; nature and primary structures of volcanic rocks, and their secondary deformation. Examples from mining districts.

333. Precious and Rare Metal Deposits (3) II
   Lacy-Mitcham
   Outstanding uranium, gold, silver, alloy metal, and rare-earth deposits. 2R, 3L, which include one field trip. Fee, $5.

334. Theories of Ore Deposition (3) II
   Lacy
   Theories pertaining to origin, concentration, transport, and deposition of elements constituting ore deposits. 2R, 3L. Fee, $2.

335. Quantitative Determinations of Aquifer Performance (3) I
   Harshbarger
   Methods of determining permeability, transmissibility, storage, specific yield, and other hydraulic characteristics of aquifers. Use of laboratory and field methods to determine amounts of ground water available for development of adequate and safe supplies. Field trips. 2R, 3L. P, 235, Physics 20, Math. 79b. Fee, $4.
GEOLOGY

336. Appraisal and Development of Water Supplies (3) II  
Harshbarger  
Survey of the geologic controls of hyrologic systems and water provinces, studies of type areas and the application of geology to the successful development of ground-water supplies. Principles of well field design and preparation of ground-water reports. Field trips. P, 335. Fee, $4.

360. Physics of the Earth (2) II 1960-61  
Pye  
Internal constitution of the earth; figure of the earth; distribution of density, temperature, and rock layers within the earth; viscosity, plasticity, elasticity, and rigidity of the earth; earth currents, earth magnetism, and seismicity.

365. Isotope Geology (2) I  
Damon  
Systematic study of processes occurring in nature which result in changes in the relative distribution of the stable isotopes. Application to problems such as the measurement of paleotemperatures, the juvenile water problem, the origin of carbon in rock and the, the origin of oil associated with salt domes. Techniques such as isotopic tracing and isotope dilution will be introduced.  
(Identical with Geochronology 365)

370a-370b. Stratigraphic Paleontology (3-3) Yr. 1960-61  
Miller  
Advanced studies of invertebrate index fossils and their regional distribution. One field trip. 2R, 3L. Fee, $8.  
(Identical with Geochronology 370a-370b)

371a-371b. Advanced Invertebrate Paleontology (4-4) Yr. 1959-60  
Miller  
Advanced studies of the taxonomy and morphology of fossil invertebrates. One field trip. 2R, 3L. Fee, $8.  
(Identical with Geochronology 371a-371b)

375a-375b. Palynology (3-3) Yr.  
Martin  
(Identical with Geochronology 275a-375b)

380a-380b. Advanced Stratigraphic Geology (3-3) Yr.  
Schreiber  
Advanced studies in the principles of stratigraphic geology.  
(Identical with Geochronology 380a-380b)

385. Carbonate and Other Chemical and Bio-Chemical Sediments (3) II 1960-61  
Pye  
Physical-chemistry of non-clastic sediments; environments of deposition; post-depositional changes; laboratory techniques of analysis. 2R, 3L. Field trip. P, 312. Fee, $5.

399. Seminar (1-3) I, II  
Staff

A. Engineering Geology
B. Petroleum Geology
C. Ground-Water Geology
D. Metaliferous Geology
E. Non-metaliferous Geology and Industrial minerals
F. Coal
G. Geochemistry
H. Mineralogy
J. Crystal Chemistry
K. Stratigraphic Geology
L. Structural Geology
M. Geomorphology
N. Petrology
P. Vertebrate Paleontology
R. Invertebrate Paleontology
S. General Geophysics
T. Applied Geophysics
U. Areal or Regional Geology
V. Sedimentation
W. Photogeology

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II  
Select by fields as given in 399.

400. Research (1 to 4) I, II  
Select by fields as given in 399.

410. Thesis (2 to 4) I, II  Maximum total credit permitted, 8 units

420. Dissertation (1 to 9) I, II

Related courses which may be taken for credit in Geology:

GEOCHRONOLOGY 300. Methods in Geochronology (3) I  
Smiley-Staff

GEOCHRONOLOGY 301. Laboratory Methods in Geochronology (2) II  
Smiley-Staff

GEOCHRONOLOGY 305. Paleoclimatology (3) II  
Staff

GEOCHRONOLOGY 331. Pleistocene Biology (2) I 1959-60  
Martin

GEOCHRONOLOGY 399. Seminar (1 to 4) I, II  
Staff

GEOCHRONOLOGY 400. Research (1 to 4) I, II  
Staff
GERMAN

Professor Frederick J. Schmitz, Ph.D., Head
Associate Professor Jean R. Beck, Ph.D.
Instructors Thomas Smitham, M.A., David J. Woloshin, M.A.

In agreement with general practice, a graduate desiring to work for the degree of Master of Arts in German should have completed an undergraduate major in German including the required 24 units (16 of them in upper division) in addition to elementary German 1a-1b, or equivalent work at another institution. Included in the 30 units of graduate work for the master's degree (15 of them in German chosen from courses offered for graduate credit) is a thesis covering two to four units.

201. Nineteenth Century Authors (2) I 1960-61 Smitham
Intensive study of one author each semester. P, 16 units in German.

203a-203b. Survey of Classical German Literature (3-3) Yr. 1959-60 Smitham
P, 3b. 230a is not prerequisite to 230b.

205a-205b. German Literature of the Nineteenth Century (3-3) Yr. 1960-61 Beck
P, 3b. 205a is not prerequisite to 205b.

207a-207b. Goethe's Faust, Parts I and II (2-2) Yr. 1960-61 Schmitz
P, 3 years, or in exceptional cases, 2 years of college German. 207a is not prerequisite to 207b.

209. Modern German Literature (2) II 1960-61 Smitham
Class and collateral reading; lectures and reports in Germany. P, 16 units in German.

300a-300b. History of German Literature (2-2) Yr. 1959-60 Beck
Historical survey of German literary development from the beginning to the present. Lectures in German alternating with conferences in English. P, 20 units in German.

INDIVIDUAL STUDIES

299. Special Problems I, II (1 to 5)

400. Research (1 to 3) I, II

410. Thesis (2 to 4) I, II Maximum total credit permitted, 8 units

GOVERNMENT

Professors ————, Head, Neal D. Houghton, Ph.D., Paul Kelso, Ph.D., Charles O. Hucker, Ph.D. (Oriental Studies)

Associate Professors Rosendo A. Gomez, Ph.D., Bernard C. Hennessy, Ph.D.

Assistant Professors Richard K. Burke, Ph.D., Dean E. Mann, Ph.D.

The department offers a graduate program leading to the degree of Master of Arts.

209. Studies in Federal Systems (3) II Mann
The theory and practice of federal systems of the world with comparative analyses related to particular cultural, economic, and historical settings. P, 2 and 3.

P, 2 and 3.

See page 38 for Master of Education degree major or minor in this department.
214. State and Local Government and Administration in Arizona (2) II 1959-60
Kelso
History, structure, organization, powers, and procedures of Arizona state and local government and administration. P, 2 and 3.

Houghton
A survey of the problems involved in domestic welfare and foreign relations, and their political implications; current and pending efforts to find solutions. 215a is not prerequisite to 215b.

218. Political Aspects of Law Enforcement and Crime Control (3) II
Houghton
The political science of the problems of law enforcement which challenge our democracy. P, 6 units from the fields of government, history, sociology, psychology, or economics.

221a-221b. Development of Political Theory (2-2) Yr.
Gomez
Evolution of European and American political doctrines, with emphasis upon the forces producing the doctrines. P, 6 units in upper-division government, history, or philosophy.

224. Recent Political Thought (3) I
Gomez
An examination and analysis of the main political doctrines since the mid-nineteenth century with emphasis on socialism, communism, fascism, and democracy.

226. American Political Thought (3) II
Gomez
American political ideas from colonial times to the present. P, 2 or equivalent.

231. Political Parties (3) I
Hennessy
An examination of the nature, structure, and functions of political parties. Emphasis on the role and activities of parties in western democracies. Special attention to American parties, their history, and current problems of organization, ideology, and leadership. P, 1 or 2.

232. Pressure Groups (3) II
Hennessy
An analysis of the formation, structure, and place of pressure groups in the democratic society, the function of interest groups in the political process; the problems of leadership, internal organization, and membership loyalties. P, 1 or 2.

233. Political Behavior (3) II
Hennessy
A consideration of the psychological and social aspects of political activity, including personality factors, the structuring of political beliefs and values, leadership, membership, participation, and political decision-making. P, 1 or 2.

235. Public Opinion (3) I
Hennessy
The nature of public opinion and its role in the political process; myths and symbols in opinion formation; propaganda, newspapers, radio, motion pictures, and other media of communication. P, 2.

237. The Legislative Process (3) II
Mann
A study of the role of the legislature in the framework of the national and state governments. Consideration of the influence of the parties, pressure groups, public opinion, constituencies, the "committee system," the "administration," the Constitution, etc., in the law-making process. P, 1 or 2.

240. Government in the Far East (3) I
Hucker
The political traditions of China and Japan and the organization and functions of their governments.

241. Governments of South Asia (3) II
Mahar
The political traditions of Hindu India, Moslem India, and British India, and the organization and functions of the modern governments of India and Pakistan.

242. Government in Great Britain (3) I
Staff
The organization, powers, and functions of the British government of modern times.

243. Governments in Western Europe (3) II
Staff
Organization, powers, and functions of the governments of western Europe with particular attention to France, Italy, West Germany, Switzerland, and Scandinavia.

244. Government in the Soviet Union (3) II
Staff
Organization, powers, and functions of the political forces in the Soviet Union with some attention to international communism.
247. Governments of Latin America (3) I Gomez
Organization, powers, and functions of the major Latin-American countries.

255. American Foreign Policy (3) I Houghton
Analytical history of American foreign policies and practices; recent and current developments and trends.

256. International Law (3) II Houghton
Origin and development of international law; recent and current developments and trends. P, 255 or 259.

259. International Relations (3) I Houghton
Development of modern international cooperation and international organization; the League of Nations; the United Nations; current challenges and prospects; position of the United States. P, 2 or Modern European History.

261a-261b. Public Administration (3-3) Yr. Kelso
The development, organization, functions, and problems of national, state, and local administration.

263. The Administrative Process (3) I Mann
A detailed study of the processes of making and executing policy within the executive branch of the government with special emphasis upon the influence of parties, pressure groups, public opinion, congressional committees and leaders, and in-administration interests. P, 2.

266. Problems of Municipal Management (3) I 1959-60 Kelso
A study of the significance, organization, and processes of management on the municipal level. P, 2 and 3.

267. Public Personnel Administration (3) I Mann

272a-272b. Principles of Constitutional Law (3-3) Yr. Burke
A study of the principles and concepts of the constitution as revealed in leading decisions of the courts. Part I: The development of the concepts and principles of judicial review, federalism, separation of powers, and implied powers. Part II: The development and current usages of constitutional limitations such as due process of law, equal protection, the contract clause, etc. P, 1 or 2. 272a is not prerequisite to 272b.

274. Legal Aspects of Administration (3) I 1960-61 Burke
A study of the law governing the organization, powers, and procedures of the executive and administrative establishment, with emphasis upon the limitations imposed by the American constitutional system. P, 2.

277. Jurisprudence and Legal Systems (3) II 1960-61 Burke
A study of the nature, sources, and theories of law; the role of law in modern society; the application of various theories of law to the legal and political system of major governments. P, 1 or 2.

279. The Judicial Process (3) II 1959-60 Burke
A study of the structure, function, and processes of the "third branch" of the American government with particular emphasis on factors influencing decision-making. P, 1 or 2.

304. Studies in State and Local Government (2) II 1960-61 Kelso
Intensive study of selected problems of structure, organization and powers of state and local government; intergovernmental relations; administrative and personnel management; special application to Arizona. Open to seniors and graduate students.

Intensive study of selected aspects of the problems and functions of our national government. Open to senior and graduate students.

350. Studies in International Politics (2) II Houghton
Intensive study of selected topics in the field of international relations and American foreign policy. Open to seniors and graduate students.

399. Seminar (2) I, II
A. Comparative Government, I Staff
B. Public Law, I Burke
C. Latin-American Government, II Gomez
INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 4) I, II
410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units

HEALTH EDUCATION

Committee

Professors Kenneth F. Wertman, Ph.D., Chairman (Bacteriology), Merwin R. Chappel, M.D. (Director of Health Services), Joseph L. Picard, M.S. (Physical Education for Men), Mary Pilgrim, M.S. (Physical Education for Women), Ole A. Simley, Ph.D. (Psychology)

Associate Professors Paul J. Danielson, Ph.D. (Education), Jack E. Hansma, Ed.D. (Health Education)

Assistant Professor William H. King, Jr., D.Ed. (Health Education)

No advanced degree in health education is offered. The courses listed below may be included in graduate study programs approved by other departments.

263. Personal Health Problems of Health Education (3) II Hansma
   An advanced study of personal health problems, involving physical, mental, and emotional aspects. P, Health 42.

264. Critical Analysis of Health Education (3) I 1960-61 Hansma-King
   Curriculum materials and instructional methods in the fields of health and safety education will be presented and discussed. Emphasis will also be placed upon analysing in-service programs and techniques of evaluation. Textbooks, periodicals, and current research bearing on pertinent methods and materials will be studied. P, 6 units of education and Health 71.

265. Field Work in Health Education (3) II 1959-60 Hansma-King
   An opportunity to work with local selected health agencies. Introducing job opportunities and experience in community organization, planning, and conducting meetings. P, Health 42, 71, Soc. 2.

266. Administration and Coordination of School Health (3) I 1959-60 Hansma
   Administrative aspects of school health program. For administrators, health coordinators, and supervisory personnel. P, 42, 71.

267. International Health Problems (2) I 1960-61 Hansma-King
   The role of the World Health Organization and other international health agencies in promotion of the health of the world.

268. Principles of School and Community Health Programs (3) 1960-61 Hansma
   Advanced study of role of the teacher and nurse in the school health program. P, Health 42, 71, or equivalent. Fee, $1.

271. Safety Education (2) I 1959-60 Hansma-King
   This course will analyze the accident-prevention methods and programs as established in industry, school, farm, and home. Considerable time will be devoted to a plan of safety instruction in the elementary and junior and senior high school. P, 6 units of education and Health 71. Fee, $1.

272. Safety and Traffic Education (2) II King
   Principles of accident prevention and safety education with emphasis on driver education and traffic safety in secondary schools. Fee, $2.

HISTORY

Professors Russell C. Ewing, Ph.D., Head, Howard A. Hubbard, Ph.D., Charles O. Hucker, Ph.D. (Oriental Studies)

Associate Professors Herman E. Bateman, Ph.D., James A. Beatson, Ph.D., John A. Carroll, Ph.D.
Assistant Professors James Donohoe, Ph.D., Joseph G. Oswald, Ph.D.

Students wishing to work for the degree of Master of Arts in history should have completed the undergraduate major in history or an acceptable equivalent. Students may be required to pursue without graduate credit such fundamental courses in history as the department deems necessary to provide a suitable background. Completion of 30 units of graduate credit in history and demonstration of a reading knowledge of one foreign language are required.

*See page 38 for Master of Education degree major or minor in this department.*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Years</th>
<th>Textbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>201a-201b</td>
<td>Colonial America, 1607-1763</td>
<td>2-2</td>
<td>1959-60</td>
<td>Beatson</td>
</tr>
<tr>
<td>203</td>
<td>The Age of Washington, 1763-1800</td>
<td>3</td>
<td>1959-60</td>
<td>Carroll</td>
</tr>
<tr>
<td>205a-205b</td>
<td>The Early National Period; 1800-1850</td>
<td>3-3</td>
<td>1959-60</td>
<td>Beatson</td>
</tr>
<tr>
<td>207a-207b</td>
<td>The Civil War and Reconstruction</td>
<td>2-2</td>
<td>1959-60</td>
<td>Beatson</td>
</tr>
<tr>
<td>209</td>
<td>History of the United States From 1876 to 1912</td>
<td>3</td>
<td>1959-60</td>
<td>Bateman</td>
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<tr>
<td>210</td>
<td>History of the United States from 1912 to 1933</td>
<td>3</td>
<td>1959-60</td>
<td>Bateman</td>
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<tr>
<td>211</td>
<td>History of the United States Since 1933</td>
<td>3</td>
<td>1959-60</td>
<td>Bateman</td>
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<td>213a-213b</td>
<td>Constitutional History of the United States</td>
<td>3-3</td>
<td>1960-61</td>
<td>Bateman</td>
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<td>215a-215b</td>
<td>History of the West</td>
<td>3-3</td>
<td>1960-61</td>
<td>Carroll</td>
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<td>216</td>
<td>History of Arizona</td>
<td>2</td>
<td>1959-60</td>
<td>Carroll</td>
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<td>218</td>
<td>The Diplomatic History of the United States in the Twentieth Century</td>
<td>3</td>
<td>1959-60</td>
<td>Bateman</td>
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<tr>
<td>221</td>
<td>History of Spain and Portugal</td>
<td>3</td>
<td>1959-60</td>
<td>Ewing</td>
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<tr>
<td>222a-222b</td>
<td>History of Latin America</td>
<td>3-3</td>
<td>1959-60</td>
<td>Ewing</td>
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<td>223a-223b</td>
<td>Latin America and the United States</td>
<td>2-2</td>
<td>1959-60</td>
<td>Shirley</td>
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<td>229a-229b</td>
<td>History of Mexico</td>
<td>2-2</td>
<td>1959-60</td>
<td>Ewing</td>
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<td>Course Code</td>
<td>Course Title</td>
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<td>231</td>
<td>Greek History (3) I</td>
<td>Hubbard</td>
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<td></td>
<td>Greece to the death of Alexander; the political, social, and economic life of the Greek people.</td>
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<td>232</td>
<td>Roman History (3) II</td>
<td>Hubbard</td>
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<td></td>
<td>The organization of the Republic and the Empire; the social and economic development of the people; the relation of Rome to the Mediterranean world; to the fall of the Empire.</td>
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<td>241a-241b</td>
<td>Medieval Europe (3-3) Yr. 1960-61</td>
<td>Donohoe</td>
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<td></td>
<td>A detailed consideration of political, social, and religious institutions, as well as an examination of the intellectual and cultural achievements of the Middle Ages.</td>
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<tr>
<td>243</td>
<td>The Renaissance and Reformation (3) I 1959-60</td>
<td>Donohoe</td>
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<tr>
<td></td>
<td>A survey of the social, intellectual, and cultural history of the fifteenth and sixteenth centuries.</td>
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<tr>
<td>245a-245b</td>
<td>Intellectual History of Europe (3-3) Yr.</td>
<td>Donohoe</td>
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<td></td>
<td>Dominant ideas in Western Civilization from the eve of the Italian Renaissance to the period of World War One.</td>
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<tr>
<td>248</td>
<td>The French Revolution and Napoleon (3) II 1959-60</td>
<td>Donohoe</td>
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<tr>
<td></td>
<td>A survey of the origins and progress of the Revolution in France.</td>
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<td>251a-251b</td>
<td>Nineteenth-Century Europe (3-3) Yr.</td>
<td>Oswald</td>
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<td></td>
<td>The evolution of the European state system after the Congress of Vienna, together with a consideration of liberalism, socialism, and imperialism.</td>
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<td>253a-253b</td>
<td>Twentieth-Century Europe (2-2) Yr. 1959-60</td>
<td>Donohoe</td>
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<td></td>
<td>A detailed study of the origins of the two World Wars and their consequences, as well as some consideration of European cultural history since 1900.</td>
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<td>255a-255b</td>
<td>Modern Germany (2-2) Yr. 1960-61</td>
<td>Donohoe</td>
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<td></td>
<td>Survey of German history since 1648, including the rise of Brandenburg Prussia, Bismarck, the wars of unification, the Wilhelmine era, the Weimar Republic, and a detailed analysis of the Hitler regime.</td>
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<td>257a-257b</td>
<td>The British Empire (3-3) Yr. 1960-61</td>
<td>Beaton</td>
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<td></td>
<td>I: The first empire; British North America in the eighteenth century; the East India Company; Oceania, Australia, and the British at the Cape of Good Hope.</td>
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<td>II: Age of Free Trade; new nations overseas; the Boer war; Dominion status; the empire between the two world wars; World War II and its aftermath.</td>
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<td>261</td>
<td>History of Russia (3) I</td>
<td>Oswald</td>
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<td></td>
<td>A study of political, social, economic, and cultural developments from the founding of the Russian state to 1917.</td>
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<td>262</td>
<td>History of the Soviet Union (3) II</td>
<td>Oswald</td>
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<td></td>
<td>The Bolshevik Revolution and problems of Soviet Russian history from 1917 to the present.</td>
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<td>265</td>
<td>History of World Communism (3) I 1960-61</td>
<td>Oswald</td>
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<td></td>
<td>An analysis of regional and national Communist movements as reflected in the foreign policy of the Soviet Union.</td>
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<td>269</td>
<td>The Balkans and the Near East (3) I 1959-60</td>
<td>Oswald</td>
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<td></td>
<td>A political and socio-economic study of the Ottoman Empire and the Balkans since 1453.</td>
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<td>272</td>
<td>Muslim World (3) II</td>
<td>Oswald</td>
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<td></td>
<td>A survey of Middle East history and the rise of Arab nationalism since 1800.</td>
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<td>275a-275b</td>
<td>History of China (3-3) Yr.</td>
<td>Hucker</td>
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<td></td>
<td>A survey of the historical development of China from earliest times to the present.</td>
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<td>277a-277b</td>
<td>History of Japan (3-3) Yr.</td>
<td>Staff</td>
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<tr>
<td></td>
<td>A survey of the historical development of Japan from earliest times to the present.</td>
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<td>291a-291b</td>
<td>Historiography and Methods (2-2) Yr.</td>
<td>Bateman</td>
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<td></td>
<td>A study of great historians and of the techniques of historical research, criticism, and writing.</td>
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<tr>
<td>298</td>
<td>Seminar of Latin America (2-2) Yr.</td>
<td>Ewing-Staff</td>
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<td></td>
<td>Identical with Spanish 298.</td>
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399. Seminar (2)
   A. United States History, I
   B. Latin-American History, II
   C. European History, I
   D. Oriental History, II

   INDIVIDUAL STUDIES

299. Special Problems (1 to 5) Yr.

400. Research (2 to 4) I, II

410. Thesis (2 to 6) I, II  Maximum total credit permitted, 6 units.

HOME ECONOMICS

Professors Ruth C. Hall, Ph.D., Director, School of Home Economics, Victor A. Christopherson, Ed.D., Mildred R. Jensen, M.S., Ethel M. Thompson, Ph.D.

Associate Professors Ruth A. Allen, M.S., Elizabeth M. Birong, M.S., Wilma Johnson, M.Ed. (H.E.), Mary A. Wood, M.S.

Assistant Professors Catherine M. Adams, M.S., Alice Books, M.S., Eleanor Ragon, M.S., Frances Stromberg, M.S.

Graduate work leading to the Master of Science degree with a major in home economics is available in five fields of study: food and nutrition; clothing, textiles, and related art; home economics education; home management-family economics; and child development and family relations.

See page 38 for Master of Education degree major or minor in this department.

CHILD DEVELOPMENT AND FAMILY RELATIONS

237. Family Relations (3) I, II  Christopherson
A study of the modern family and its relationships beginning at marriage and continuing through subsequent phases of the family cycle. Emphasis will be placed upon marital adjustment, parenthood, family composition, and inter-personal behavior. Open to upper-division men and women.

247. Readings in Child Development and Family Relations (2) I  Christopherson-Stromberg
Survey and evaluation of literature in the field with implications for teaching and parent education. Open to men and women. P, 27, 147 or equivalent.

257. Child Rearing Practices and Their Cultural Determinants (3) II  Christopherson
A study of the influence of various national subcultures upon child rearing practices. Such factors as regional, ethnic, religious, and socio-economic influences along with peer groups, ascribed status, and family composition will be considered. P, 27, and Sociology 1.

267. Preschool Teaching (3-5) II 1960-61  Stromberg
Supervised teaching in the preschool laboratory. Special consideration of individual and group needs, guidance, and program planning in preschools. 2R plus L to be arranged. P, 147.

327. Problems in Child Development (3) II 1959-60  Stromberg
Study of the child behavior at the pre-school level; review of recent research in the field. Open to men and women. P, 147, Psychology 13.

CLOTHING, TEXTILES, AND RELATED ART

204. Buying Textiles and Clothing (3) II  Birong
A comparative study of type and quality of ready-to-wear clothing and household textiles. P, 94 and junior standing.

225. History of Costume (3) I  Allen
Details and silhouettes of historic clothing as an expression of the artistic, social, and economic life of the periods. P, History 4a or Humanities 50a-50b.
254. Recent Developments in the Textile Field (3) II 1959-60 Jensen
Readings, reports, and discussions based on current literature and research in the
textiles and clothing field, including the social, economic, and psychological phases.
P, 204.

255. History of Furniture (3) I 1956-60 Jensen
A study of period furniture from Egyptian through contemporary styles. P, History 4a or Humanities 50a-50b.

264. Drafting and Flat Pattern Designing (2) I 1959-60 Staff
Preparation and use of a foundation pattern sloper for creating original clothing
designs. P, 44. Fee, $2.

265. History of Decorative Textiles, China, Glass,
and Silver (3) I 1960-61 Jensen
A study of period styles. P, History 4a, Humanities 50a-50b, or Art 7a-7b.

275. Contemporary Trends in Home Furnishing (3) II 1960-61 Jensen
The study of adaptations of period design; contemporary interiors for modern homes.
1R, 6L. P, 255 or 265.

294. Textile Analysis (2) I 1960-61 Jensen
Physical testing of fabrics for comparison of qualities. For majors in textiles and
clothing. 1R, 3L. P, 94. Fee, $3.

FAMILY ECONOMICS AND HOME MANAGEMENT

216. Management of Family Resources (2) I Books
A study of the resources available to families and the use of these resources to obtain
family goals. P, 16 and Economics 1a.

246. The Consumer and the Market (3) II Books
Consideration of the market agencies from the standpoint of advantages and disadvan-
tages to the consumer; consumer buying problems under existing market conditions.

306. Economic Problems of the Family (2) II Hall
A study of the economic position of American families in terms of incomes, prices,

FOOD AND NUTRITION

202R. Nutrition (2) I Thompson
Fundamental principles of human nutrition; nutrient requirements and dietary plan-
nning. P, Chemistry 1b.

202L. Nutrition Laboratory (2) I Thompson
Calculation of nutrients in food and preparation of diets to meet human require-
ments. Animal-feeding experiments. 6L. P, 202R or CR.

221. Buying Food and Equipment for Institutions (2) II Wood
Factors affecting food purchasing and the selection of equipment for institutions.
P, 91.

222. Readings in Nutrition (2) II Thompson
Preparation of abstracts and bibliographies of publications in scientific literature.
Oral reports. P, 202R.

232. Diet Therapy (3) II Thompson
Adaptation of diet to disease. P, 202R.

241. Institution Organization and Administration (3) II Wood
Management problems in food preparation and service; organization and arrange-
ment of work units; sanitation; care and maintenance of plant. P, 91.

242. Community Nutrition (2) I 1959-60 Adams
Problems involved in the improvement of nutritional practices in a community.

302. Chemistry and Metabolism of Lipids (2) I 1959-60 Thompson
The chemistry and metabolism of lipids with emphasis on recent contributions and interpretations. P, 202R or Chemistry 260a-260b and 261a-216b; 6 units of organic chemistry; Zoology 253a or equivalent.
(Identical with Agricultural Biochemistry and Nutrition 302)
HOME ECONOMICS EDUCATION

Opportunities are available for graduate students to plan and conduct studies on professional problems in home economics education.

Applicants for admission to graduate study must have a bachelor's degree from an approved college for the training of vocational teachers with a major in home economics education. The student's previous course work should be in the equivalent of that required for the major in home economics education at the University of Arizona and should include a minimum of 18 semester credits in psychology, educational psychology, vocational education, special methods of teaching, and directed teaching.

The degrees of Master of Science and Master of Home Economics Education are offered. The major field of study shall include a minimum of 20 units in home economics and home economics education. The additional supporting course work shall be in education and other approved subjects appropriate to the student's teaching field.

A total of 30 credits including a thesis is required for the Master of Science degree. A total of 32 units of course work is required for the degree of Master of Home Economics Education. A thesis is not required, but candidates for the degree must complete a research problem. Graduate courses are offered each summer session to aid students in completing degree requirements.

208. Planning and Supervising Home Experience (3) I Johnson
Consideration of the responsibilities and activities of the home economics teacher in the extended school program; the value of home projects, home visits, and Future Homemakers of America. 2 one-hour lectures each week, first six weeks professional semester. Two weeks supervised experience in selected community. P, 108.

209. Teaching Out-of-School Groups (2) II Barkley
A study of methods of teaching out-of-school groups. Special emphasis and experience in teaching adults. Observation and supervised teaching in adult program. P, 189 or teaching experience.

310. Investigation and Studies in Home Economics (2) I Barkley
A critical study of the research literature and research techniques appropriate to the solution of problems in home economics. Selecting a problem and developing procedures for that problem.

318. Evaluation in Home Economics Education (2) II Johnson
Selection and construction of evaluation devices. Their use and interpretation in home economics programs.

328. Curriculum Planning in Home Economics in the Secondary Schools (2) I Barkley
A study of the bases and techniques of curriculum building in secondary vocational homemaking programs.

399. Seminar (2-1) I, II Staff
I. Study and reports on recent developments in curriculum, methods, evaluation, and other phases of the home economics program. P, 189 or home economics teaching experience.
II. Studies in Child Development and Family Relations.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 6) I, II Maximum 4 units except for Food and Nutrition in which it may be 6.
HORTICULTURE

Professors Leland Burkhart, Ph.D., Head, Robert H. Hilgeman, Ph.D.
Assistant Professors Steve Fazio, M.S., Joseph S. Folkner, M.S., J. Richard Kuykendall, Ph.D.

The Department of Horticulture offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. The Doctor of Philosophy degree is offered with horticulture as a field of specialization under the Plant Science Program (see page 44).

The Department of Horticulture has facilities for graduate work in the following fields: vegetable breeding; vegetable physiology and technology; fruit physiology; landscaping; and plant propagation. Candidates in horticulture are expected to have a basic knowledge of botany, plant physiology, chemistry, physics, genetics, bacteriology, soil science, and mathematics, including statistics.

At least 22 semester units of graduate credit are required for the Master of Science degree in addition to the thesis (six to eight semester units, depending on the subject and results obtained). The candidate's program will be guided by the horticulture department in conjunction with at least one related department. The opportunity is offered in the Plant Science Program, for a doctoral candidate to undertake research in horticulture. Course work in various departments other than horticulture is desirable in connection with the advanced degrees. Acceptable related fields are agronomy, botany, entomology, plant pathology, and soils.

The department has teaching and research laboratory and greenhouse facilities on the University campus, and research laboratories and greenhouses in the Salt River Valley and in the Yuma area. The facilities of the laboratories, experimental orchards, vegetable trial groups, and landscape testing materials, are available to graduate students and provide exceptional opportunities for individual research in both fundamental and applied phases of horticulture.

208. Citriculture (2) II
   Burkhart
   Climatic requirements, varieties, rootstocks, orchard management, physiology, processing, and quality of citrus. 2R, and one 1-day field trip. P, Botany 203. Fee, $4.

221. Plant Propagation (3) II
   Fazio
   Propagation of woody and herbaceous plants, by seeds, and vegetatively, by cuttings, budding, and grafting. 2R, 3L. P, 102. Fee, $3.

222. Technology of Horticultural Products (3) II 1959-60
   Burkhart
   Harvesting, grading, packing, storage, transportation, processing, preservation of fruits and vegetables including horticultural characteristics and consumer acceptance factors. 2R, 3L. Fee, $3.

223. World Horticulture (2) II 1960-61
   Folkner-Staff
   World trends in production, consumption, breeding, and varieties of fruits, vegetables, and other horticultural plants. P, 102 or 103.

224. Landscape Design (3) II 1959-60
   Folkner

225. Nursery and Turf Management (3) I 1959-60
   Folkner

249. Fundamentals of Tree Growth (2) I 1959-60
   Kuykendall

296. Experimental Horticulture (3) I 1960-61
   Kuykendall-Staff
   Current methods of experimenting with horticultural crops, using active experiment station projects for discussion; practice in handling experimental plantings, controlling pollination, analytical procedures, assembling data. 1R, 6L. Fee, $3.

399. Seminar (1) II
   Staff
INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units

420. Dissertation (1 to 9) I, II

LIBRARY SCIENCE
(See Education, School Library Science)

MARKETING

Professors Rex V. Call, Ph.D., Head, Elwin G. Wood, Ph.D.
Associate Professor William H. Fink, Ph.D.
Assistant Professor Leahmae McCoy, Ph.D.

The Department of Marketing offers graduate programs leading to the Master of Science and to the Master of Business Administration degree.

219. Foreign Trade Techniques (3) II Fink
Practical aspects of exporting and importing, drawing upon case material derived from the experience of various business organizations. Topics include development of markets abroad, financing, documentation, and shipment, and sources of foreign trade service. P, Economics 217.

261. Marketing Principles and Practices (3) I, II Staff
Marketing methods, institutions, functions, and policies; markets, planning marketing activities. P, Accg. 1b, Economics 1b or 2b.

262. Wholesaling Principles and Practices (3) II Davis

263. Retailing Principles and Practices (3) I Davis
Organization, management, and operation of retail enterprise. P, 261.

264. Advertising Principles and Practices (3) I Wood
A basic course in the theory and practice of advertising. Introduction to planning, preparation, and use of copy, illustration, layout, and production of printed advertising; radio and television commercials; selection and use of media.

265. Advertising—Planning, Strategy, and Campaigns (2) II Wood
Planning, strategy, and research factors. Products and package design, appropriations, media schedules, trade-marks, slogans, campaign themes, dealer cooperation, premiums, and contests; research practices; the complete campaign. P, 264.

266. Advanced Advertising (3) II Drayer
Study and practice in preparing layouts and copy. P, 265.

267. Sales Management (3) I Harlan
The application of scientific methods to the selling and distribution problems of manufacturers and wholesalers. P, 261.

268. Marketing Research (3) I Staff
Methods of gathering, recording, and analyzing facts with a view to solving marketing problems. P, 261, Econ. 155.

269. Problems in Retail Merchandising (3) II Call
Study of problems current in the fields of retailing and training in scientific procedures that lead to satisfactory solutions. Emphasis on actual problems. P, 263.

270. Marketing Problems (3) II Call
A combination text and case approach to the application of basic marketing principles to typical business problems. P, 261.
MATHEMATICS

356. Sampling Theory and Methods (3) II 1959-60
(Identical with B.A. 356)  Staff

399. Seminar (2) I, II  Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II  

400. Research (2 to 4) I, II  

410. Thesis (4) I, II  Maximum total credit permitted, 4 units.

MATHEMATICS

Professors Harvey Cohn, Ph.D., Head, Roy F. Graesser, Ph.D., Evar D. Nering, Ph.D., Edwin J. Purcell, Ph.D.
Associate Professors Deonisie Trifan, Ph.D., Donald L. Webb, Ph.D.
Assistant Professors Joseph F. Foster, Jr., Ph.D., Louise C. Lim, Ph.D., Gerald S. Rogers, Ph.D., Arthur H. Steinbrenner, Ph.D., Roy E. Wild, Ph.D.
Special Professors Henry Tucker, Ph.D. (Statistics), A. Wayne Wymore, Ph.D. (Numerical Analysis Laboratory)

The department offers graduate work in several general areas.


SPECIAL PROGRAMS: (Actuarial) 292, 293; (Teaching) 211, 212, 240.

The students’ selections will not necessarily be limited to any one category and should in any case be planned individually with the department.

Master of Science. — This degree is intended for those interested in college teaching, research, or advanced degrees. Students entering must have an undergraduate major in mathematics which consists of 24 units including at least Mathematics 180 (or cognate course in differential equations) with nine additional upper-division units which, after June, 1960, must include Mathematics 280a (or cognate course in advanced calculus, higher analysis, etc.). Mathematics 280a may be taken for credit by transfer students if the cognate course varies sufficiently in the opinion of the department. Candidates must earn 30 units of graduate credit in mathematics and must demonstrate a reading knowledge of French, German, or Russian. The courses must include a two-semester course on the 300 level.

Master of Arts. — This degree is intended to meet the needs of secondary school teachers and will normally be available only to graduates of the education curriculum with a mathematics major. The corresponding undergraduate major consists of 24 units including at least Mathematics 180 (or cognate course in differential equations) and nine additional upper division units which, after June, 1960, must include Mathematics 280a (or cognate course in advanced calculus, higher analysis, etc.) or Mathematics 297 (or cognate course in foundations). Either of the latter two courses may be taken for credit by transfer students if the cognate course varies sufficiently in the opinion of the department. There is no language requirement, but 30 units of graduate credit must be earned including two two-semester courses on the 200 level or one two-semester course on the 300 level. As many as 12 units of graduate credit may be earned in an approved minor. There is no thesis requirement for either degree, but the student may also be required to do some seminar (399) work.
Doctor of Philosophy. — The general requirements for this degree are given on page 42. Language requirements may be fulfilled in any two of the following three: French, German, Russian. The preliminary examination is a comprehensive written and oral examination in three fields of mathematics fitting the needs of the candidate and approved by the Department of Mathematics. A candidate passing this examination will also have satisfied the requirements of the master's degree if he has also satisfied the course and residence requirements for that degree.

See page 38 for Master of Education degree major or minor in this department.

201. Boundary Value Problems (3) II Staff

202. Topics in Applied Mathematics (3) II Staff
Vector algebra, vector differential calculus, vector integral calculus, theorems of Stokes, Gauss, and Green; applications; Laplace transformation; elliptic integrals. (Supersedes 202a.) P, 180.

204a-204b. Projective Geometry (3-3) Yr. 1960-61 Purcell
P, 180 or 181.

210a-210b. Theory of Numbers (3) Yr. 1960-61 Cohn
Divisibility properties of integers, congruences, quadratic residues and forms, ideal factorization, primes in arithmetic progression. P, 180 or 181.

211. Advanced Euclidean Geometry (3) II 1959-60 Foster
For prospective high school teachers. P, 79a or 93a.

212. Non-Euclidean Geometry (3) II 1960-61 Foster
For prospective high school teachers. P, 95a or 79a.

230. Matrix Analysis (3) II Webb
General introductory course to the theory of matrices. P, 79b or 95b.

231. Introduction to Modern Algebra (3) I 1960-61 Webb
Introductory topics in abstract algebra, fields, groups, rings, matrices. P, 79b or 95b.

240. History of Mathematics (3) I Steinbrenner
P, 79b or 95b.

275. Numerical Analysis (3) I Wymore
(Identical with N.A. 275)

276. Advanced Numerical Analysis (3) II Wymore
(Identical with N.A. 276)

277. Computer Programming (3) I, II Staff
(Identical with N.A. 277)

278. Advanced Programming Digital Computers (3) II Staff
(Identical with N.A. 278)

280a-280b. Introduction to Analysis (3-3) Yr. Staff
280a supersedes 202b and it will emphasize the limit process in the theory of differentiation, integration, and infinite series. 280b supersedes 280 and it will include special elementary topics which can be handled with these techniques. 280a will be offered both semesters. P, 180 or 181.

281. Analysis of Variance (3) II 1959-60 Staff
An investigation of the design and analysis of experiments beginning with the chi-square test and extending to the theoretical aspects of randomized blocks, latin squares, etc. P, 291b, 230.

283. Sequential Analysis (3) II 1960-61 Staff
An investigation of this modern technique as used in testing statistical hypotheses with extension to decision functions. P, 291b.
289. Game Theory (3) I 1959-60
Games of strategy, normal form of a game, minimax theorem for two-person games, n-person cooperative and non-cooperative games, solutions of n-person games and equilibrium points, applications, and current developments. P, 79b, or 95b.

290. Introduction to the Theory of Probability (3) II
Nering
The nature of probability theory, combinatorial theorems, special distributions, laws of large numbers, random walk and problems, Markov chains, information theory. P, 180 or 181.

291a-291b. Theory of Statistics (3-3) Yr.
Rogers
Basic concepts in distribution theory, testing hypotheses, interval and point estimation with emphasis on the use of sufficient statistics. P, 180 or 181.

292. Calculus of Finite Differences (3) I 1959-60
Foster
Interpolation with equal and unequal intervals, central differences, summation, approximate integration. P, 79b or 95b.

293. Introduction to Actuarial Theory (3) I 1960-61
Graesser
Probability, mortality tables, life annuities, life-insurance premiums, reserves, non-forfeiture values, and settlement options. P, 79a or 95a.

295a-295b. Mathematical Logic (3-3) Yr.
Lim
Sentential calculus, method of education, predicate calculus. Boolean algebras; consistency, independence, completeness, and the decision problem. Designed to be of interest to majors in both mathematics and philosophy. P, 79a, 95a, or Philosophy 12a.

297. Foundations and Nature of Pure Mathematics (3) II
Purcell-Webb
Basic concepts of modern mathematics, the axiomatic method, groups, axiomatic development of the real number from the Peano axioms, well-ordered sets, and order types. P, 180 or 181.

304a-304b. Algebraic Geometry (3-3) Yr. 1959-60
Purcell
An introduction to the methods of abstract algebraic geometry, with applications to curves and varieties centering around birational transformations and linear series. P, 204a.

305. Combinatorial Topology (3) I 1960-61
Staff

306. Point Set Topology (3) I 1960-61
Staff

308. Tensor Analysis (3) I 1960-61
Trifan
The algebra and calculus of tensors with applications to algebraic and differential geometry, analytical mechanics, and the mechanics of continuous media. P, 202 or 280a.

309. Metric Differential Geometry (3) I 1959-60
Trifan
Curves and surfaces in Euclidean 3-space, Frenet-Serret formulas, developable surfaces, fundamental forms, systems of curves on surfaces, curvature, geodesics. P, 180 and 202 or 280a.

321a-321b. Theory of Functions of a Complex Variable (3-3) Yr. Cohn-Wild
Calcium of complex numbers; elementary functions; calculus of residues; conformal mapping; special functions; applications. P, 280a.

322a-322b. Theory of Functions of a Real Variable (3-3) Yr. 1960-61
Lim
Point set theory, modern theory of measure and integration, differentiation, applications. P, 280a,b.

325a-325b. Modern Algebra (3-3) Yr. 1959-60
Nering
Topics from abstract algebra, groups, rings, polynomials, linear algebra, fields, Galois theory. P, 250, 231, or 280a.

328. Function Spaces (3) II 1960-61
Staff

333. Theory of Representations of Groups (3) I 1960-61
Nering
Introduction to group theory, representation of finite groups, character tables, applications, introduction to infinite groups. P, 280a and 230, or 325a.
339. Design of Experiments (3) I  
(Identical with Gen. Ag. 339)  
H. Tucker

350a-350b. Differential and Integral Equations of Mathematical Physics (3-3) Yr. 1959-60  
Staff
Partial differential equations of the first order; partial differential equations of the second order; elliptic, hyperbolic, parabolic; Laplace's equation, wave equation, diffusion equation, and related boundary value problems; calculus of variations; linear integral equations. P, 280a.

351a-351b. Mathematical Theory of Elasticity (3-3) Yr. 1960-61  
Trifan

353a-353b. Fluid Dynamics (3-3) Yr. 1960-61  
Staff
General equations of motion, perfect fluids, two-dimensional incompressible steady flow past a single airfoil, vortex motion, viscous fluids, theory of supersonic flow, steady and unsteady one-dimensional flows. P, 202, 321b.

382. Non-Parametric Methods (3) I 1960-61  
Staff
An investigation of material from texts and journals presenting "old" and "new" techniques in this field of statistical inference and hypothesis testing. P, 291b.

383. Statistical Hypotheses (3) I 1959-60  
Rogers

391a-391b. Advanced Theory of Statistics (3-3) Yr. 1960-61  
Rogers
An investigation in broad generality of various topics in statistical theory such as foundations of probability theory, use of Fourier transforms, multivariate analysis, decomposition of Chi-square variables, etc. P, 291b, 321b, 230.

399a. Seminar in Algebra (1-6) I, II  
b. Seminar in Analysis (1-6) I, II  
c. Seminar in Geometry (1-6) I, II  
d. Seminar in Logic (1-6) I, II  
e. Seminar in Number Theory (1-6) I, II  
f. Seminar in Mathematical Physics (1-6) I, II  
g. Seminar in Numerical Analysis and Computer Techniques (1-6) I, II  
h. Seminar in Statistics (1-6) I, II

These seminars will supplement the regular courses by presenting related but different material.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5)  
400. Research (2 to 8) I, II  
410. Thesis (3 to 6) I, II Maximum total credit permitted, 6 units.  
420. Dissertation (1 to 9) I, II

MECHANICAL ENGINEERING

Professors Harvey D. Christensen, Ph.D. Head, Manfred R. Bottaccini, Ph.D., Heliodore A. Marcoux, M.S., Martin L. Thornburg, M.E.
Associate Professors Arland G. Foster, M.S., Allen R. Joyce, M.S., A. Ralph Yappel, M.S.
Assistant Professors John S. Phelps, M.S., Quentin R. Thomson, M.S.

The Department of Mechanical Engineering offers the degree of Master of Mechanical Engineering as well as Master of Science and Doctor of Philosophy degrees in Mechanical and in Aero-Space Engineering. Each student entering graduate work must have undergraduate credits equivalent to those required for a Bachelor of Science in mechanical or aero-space engineering at the University of Arizona.
AERO-SPACE ENGINEERING

The aero-space engineering curriculum prepares the student for entry into the well-established field of aeronautical engineering. In addition, the subject matter relevant to the new field of space and missile technology has been integrated into the program. The descriptions of the aero-space engineering courses (ME 260 to 279 and ME 360 to 379) have been included in the following listing with the mechanical engineering courses. There are many courses of common interest to both curricula.

MECHANICAL ENGINEERING

The mechanical engineering curriculum prepares students for entry into the well-established options of production, tooling, design, mechanics, thermodynamics and aero-space engineering. The courses below are listed using the following code system:

Production, Tooling and Design: 200-219 and 300-319
Theoretical and Applied Mechanics: 220-239 and 320-339
Theoretical and Applied Thermodynamics: 240-259 and 340-359
Aero-Space Engineering: 260-279 and 360-379

202. Production Engineering (3) I, II
Economic production principles, design relationship to materials and production processes, tooling, quality control, and packaging. 2R, 3L. P, 102. Fee, $8.

203a-203b. Tooling Engineering (3-3) Yr.
An analytical approach to the general and specific problems in the field of tool engineering, the fundamentals of work-holding and tool-guiding devices, the cutting action and forces involved, with a challenge to the creative ability of the student to see the individual step in relation to the field. 2R, 3L. P, 102. Fee, $5.

204. Industrial Management (2) I, II

206a-206b. Engineering Statistics and Quality Control (3-3) Yr.
Fundamental statistics, calculus of probability, test of hypotheses, variance and design of experiments, basic quality control techniques, process and instrumentation analysis, non-parametric statistics, and sequential analysis. P, Math. 180.

210a-210b. Mechanical Engineering Design (3-3) I, II
Application of the theories and laws of the engineering sciences to creative design problems. 2R, 3L. P, 120 and 130. Fee, $2.

211. Advanced-Machine Design (3) II
Components of machines and their relationship on the basis of material, strength, cost, service, and manufacture and assembly. 2R, 3L. P, 111b of CR. Fee, $2.

214. Plant Engineering (3) I
Mechanical systems and their components, controls, specifications, and economic considerations; plant layout. Field Trip Fee, $3. 2R, 3L. P, 130 and 142.

220. Mechanical Behavior of Materials I (3) I
Advanced study of the physical properties of engineering materials used where high strength and toughness, wear and abrasion resistance, high temperature or chemical corrosion are factors. P, 120.

221. Mechanical Behavior of Materials II (3) II
Study of non-metallic materials (organic and inorganic); properties of materials based on structure and manufacture and their influence on design; plastics, nylon, ceramics, machining surface finish, casting, cement, and lubricants. P, 120.

222. Experimental Elasticity (3) I
Experimental verification of the principles of theory of elasticity and application of modern techniques in experimental stress analysis to typical problems in mechanical and aeronautical structure. 2R, 3L. P, 132. Fee, $5.

231a-231b. Mechanical-Engineering Dynamics (2-2) Yr.
Application of the basic principles of mechanics to mechanical engineering problems involving dynamics: systems having one or more degrees of freedom, damping, forced and free vibration, vibration isolation and absorption, instruments and introduction to nonlinear problems. P, 132.
232a-232b. Mechanical-Engineering Analysis (3-3) Yr. Bottaccini

233a-233b. Theory of Structures (3-3) Staff
Theory and application of principles of mechanics to structural analysis of mechanical and aeronautical components. P, 132 and 120.

241. Thermodynamics of Fluid Flow (3) I Yappel
Basic concepts of gas dynamics and fluid properties, fundamental equations of steady, one-dimensional flow; qualitative and quantitative analysis of isentropic, diabatic, frictional, and generalized variable area flow and shock wave phenomena. P, 130.

252. Internal Combustion Engines (3) II Thomson
Idealized cycles and processes of reciprocating engines, gas turbines, and propulsion jets; fuels and combustion phenomena, theories of lubrication. 2R, 3L. P, 152. Fee, $2.

261a-261b. Aerodynamics (3-3) Yr. Staff
Developments of the fundamentals of incompressible and compressible fluid theories and the application. P, 161 and 241 or CR.

262a-262b. Aero-Space Dynamics (3-3) Yr. Staff
Development of the basic principles of rocket flight including conservation of energy concepts, Kepler's laws, the general equations of motion of a projectile, and application of these principles to the dynamics of a rocket. P, 161.

263. Experimental Aerodynamics (2) I, II Staff
Modern methods for obtaining experimental aerodynamic data, wind tunnel calibration, correction factors, use of associated instrumentation and extrapolation of model results to full scale. 1R, 3L. P, 261a or CR. Fee, $4.

272. Automatic Control and System Analysis (3) I Staff
Applications of operational methods to the analysis and synthesis of automatic systems. 2R, 3L. P, 132 or equivalent. Fee, $3.

273. Theory of Instrumentation and Control (3) II Bottaccini

274. Aero-Space Equipment Design (3) I 1960-61 Bottaccini

275. Flight-Test Techniques (3) II 1960-61 Staff
Methods of obtaining aerodynamic data by means of flight testing (manned or unmanned), instrumentation requirements, types of testing, and flight test procedures. 2R, 3L. P, 161. Fee, $8.

303. Advanced Tooling Engineering (3) I 1960-61 Foster
Press working of metals and plastics; the adaptability of materials to the many processes ranging from simple shearing to plastic extrusion; the calculations of press sizes and types required; also stretch forming, coining, hot and cold rolling, and drawing. 2R, 3L. P, 205b. Fee, $5.

331a-331b. Nonlinear Oscillations (2-2) 1960-61 Christensen

341. Advanced Thermodynamics (3) I Staff

342. Advanced Heat Transfer (3) II Staff
Further study of heat transfer, with emphasis on transient conditions. P, 241.

343. Microscopic Thermodynamics (3) II 1960-61 Staff
Applications of probability theory to microscopic behavior. P, 341.
METEOROLOGY AND CLIMATOLOGY

355. Rotative Fluid Systems (3) II
   Energy transfer principles between fluid and rotor in a general treatment of all
   forms of turbomachines using compressible and incompressible fluids. These principles
   are then applied to several kinds of pumps, compressors, and turbines, grouping them
   into similar flow patterns rather than by specific application. P, 241.

361a-361b. Advanced Aerodynamics (3-3) Yr. Staff
   Developments of the fundamentals of viscous fluid theory and heat conductivity

362a-362b. Advanced Aero-Space Dynamics (3-3) Yr. Bottaccini
   An extension of the principles of 262a-262b, and including effect of jet damping,
   thrust disalignment, spinning, and unstable configurations. Development of the multi-
   body problem in flight in outer space. P, 262a-262b.

363a-363b. Aeroelasticity (3-3) Yr. Anderson
   Dynamics of the airplane or missile including the effect of aerodynamic forces and
   elasticity of the structure: generalized coordinates, aeroelastic instability, divergence,
   and flutter analysis. P, 233b and 261b.

364a-364b. Preliminary Design (Missiles and Airplane)
   (3-3) Yr. 1960-61 Staff
   Theory and practice of designing an airplane or missile from specifications. Includes
   performance, stability and control, stress analysis, weight and center of gravity com-
   putations, and a preliminary layout of the design. 2R, 3L. P, 261b and 262b.

365a-365b. Theory of Propulsion (3-3) Yr. 1960-61 Staff
   Fundamentals of rockets: solid and liquid propellant rocket theory and design.
   Ramjet, turbojet, turbofan, turboprop theory and design. P, ME 261b.

366. Stability and Control (3) I 1960-61 Bottaccini
   Control parameters and equations of motion of semirigid bodies, aerodynamics of
   control, control in space. Trajectory, stability, and perturbations. P, 261b or CR.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 5) I, II

410. Thesis (3 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

MEDICAL TECHNOLOGY
(See Bacteriology and Medical Technology)

METALLURGICAL ENGINEERING
(See Mining and Metallurgical Engineering)

METEOROLOGY AND CLIMATOLOGY

Professors A. Richard Kassander, Ph.D., Head, Louis J. Battan, Ph.D., James E.
McDonald, Ph.D.

Associate Professor William D. Sellers, Ph.D.

Instructors Earl W. McMurry, M.S., Clayton H. Reitan, S.M.

The student desiring to pursue advanced work in the field of meteorology
should in consultation with the staff, prepare himself by electing the undergraduate
courses offered plus mathematics and physics sufficient to provide the broad back-
ground in those fields needed for advanced meteorological training. This will or-
dinarily include at least one course beyond calculus and four semesters of college
physics. Supporting work in biological or earth sciences is recommended.
The department offers work leading to both the Master of Science and Doctor of Philosophy degrees. In conjunction with the Institute of Atmospheric Physics unusual facilities are provided for research in the fields of physical meteorology (especially cloud physics and radiation) and climatology (with emphasis on high-speed computing methods and arid-lands problems). The minor field and languages offered will be chosen in conference with the head of the department to suit the interests and needs of the candidate. For admission to graduate work in meteorology an undergraduate major in meteorology is not required. Applicants with undergraduate majors in mathematics and physics are encouraged to apply, since training in these fields provides excellent background for graduate work in meteorology and climatology.

Persons interested in pursuing graduate study in meteorology or climatology are strongly urged to correspond directly with the department concerning admission to candidacy.

215. Arid-Zone Agroclimatology and Micrometeorology (2) I 1960-61 Staff

221. Physical Climatology (3) II 1960-61 Sellers
The heat and water balance of the earth's atmosphere and its application to problems of physical geography, agrometeorology, and hydrology; the general circulation of the atmosphere, long-term climatic changes. P, 71.

233. Meteorological Instrumentation (3) II 1960-61 Kassander
A systematic discussion of transducers, amplification systems, and recorders, and their applications to weather observing and meteorological research instrumentation, including radar meteorology and cloud-physics applications. 3R or 2R, 3L. P, Physics 15.

235. Meteorology and Climatology of the Southwest (2) II 1959-60 Reitan
A study of the climate of the Southwest with emphasis on Arizona. Synoptic and physical climatology of the area, topics of regional interest, comparative studies of arid lands. P, 71.

241a-241b. Physical and Dynamical Meteorology (4-4) Yr. Staff
Meteorological thermodynamics and statics, principles of atmospheric radiation, kinematics and dynamics of atmospheric motions, methods of meteorological analysis. 4R or 3R, 3L. P, Physics 15, Mathematics 181.

317. Statistical Methods in Meteorology (3) I 1959-60 Sellers

341. Theoretical Meteorology (4) I Staff
Micrometeorology, perturbation theory, atmospheric instability, numerical weather prediction, theories of the general circulation, atmospheric tides. P, 241b, Mathematics 280a.

351. Dynamics and Microphysics of Clouds (3) I McDonald
Convection theories, cloud turbulence and entrainment, thunderstorm circulation, dynamics of wave clouds, thermodynamics of phase-change and nucleation, condensation nuclei and ice nuclei, diffusional growth of cloud drops and ice crystals, optical and electrical phenomena. P, 241a, Math. 181, Physics 225.

354. Atmospheric Electricity (3) I 1959-60 Evans
Processes of atmospheric ionization, ion-equilibrium and the conductivity of air, maintenance of the earth's vertical field, charge transfer under storm conditions, thunderstorm charges separation, the lightning discharge. P, 231a, Math. 181, Physics 215a.

356. Atmospheric Optics and Radiation (3) II 1960-61 McMurry
361. Radar Meteorology (2) I Battan
An examination of microwave propagation in the atmosphere, the scattering and attenuation of microwaves by clouds and precipitation particles and the use of radar for the study of clouds, precipitation, thunderstorms, tornadoes, and other meteorological phenomena. Available radar equipment will be utilized for demonstrations. P, 351.

364. Physics of the High Atmosphere (3) II 1960-61 Battan

399. Seminar (2) I Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 6) I, II
410. Thesis (1 to 4) I, II Maximum total credit permitted, 4 units.
420. Dissertation (1 to 9) I, II

MINING AND METALLURGICAL ENGINEERING
Professors Thomas M. Morris, Ph.D., Head, Thomas G. Chapman, Sc.D., John B. Cunningham, M.S., James D. Forrester, Ph.D., Harry E. Krumlauf, M.S., Daniel J. Murphy, Ph.D., Sigmund L. Smith, M.S.
Associate Professors John K. Anthony, M.S., Jay C. Dotson, M.S., Elmer R. Drevdahl, M.S.
Instructor Frederick L. Stubbs, B.S.
Lecturer Walter W. Walker, B.S.
Graduate courses and research leading to the following advanced degrees are offered by the Department of Mining and Metallurgical Engineering:

M.S. in Mining Engineering
M.S. in Metallurgical Engineering
M.S. in Physical Metallurgy
Ph.D. in Metallurgy

For admission to specialized study at the master's level in one of these fields, the applicant must show completion of course work equivalent to that required by the University of Arizona for the B.S. degree in the appropriate field.

Advanced work in metallurgy and metallurgical engineering is directed toward research, and the work in mining engineering to the professional development of the student by providing suitable specialization in mining and allied fields.

Candidates for the Ph.D. in metallurgy may major in either extractive metallurgy or physical metallurgy. The requirements for this degree are given on page 42.

METALLURGICAL ENGINEERING

205. Ore Microscopy (1) II Smith
The theory and practice involved in the use of various types of microscopes in the study of common minerals, concentrates, etc.; the determination of grain size; and the quantitative analysis of metallurgical products. 3L, P, 61, Geol. 8 or 10.

207.* Mineral Dressing (3) I Chapman
The crushing, grinding, and concentration of ores by mechanical methods. P, 61.

207L.* Mineral Dressing Laboratory (1) II Smith-Stubbs
Experimental work in the preparation and concentration of ores by mechanical methods. 3L, includes two field trips. P, 207 or CR. Fee, $8.
211. Hydrometallurgy and Mineral Dressing (3) II
Smith
The principles of treating copper, tungsten, uranium, gold, and silver ores by hydrometallurgical methods and the principles of crushing, grinding, and concentration of ores by mechanical methods. P, 111.

212.* Nonferrous Production Metallurgy (2) I
Cunningham
The study of various smelting and refining processes used for the treatment of copper and lead ores. P, 61. One field trip to a smelter is required. Fee, $3.

214. Metallurgical Plant Organization (1) II
Smith
To acquaint the student with the development of research, plant organization, management, industrial relations, company policies, taxes, patents, and costs for extractive metallurgical plants. P, 201 or 111.

215. Industrial Mineral Beneficiation (3) I
Stubbs
A continuation of Metallurgy 207 but emphasis on gravity, magnetic and electrostatic types of concentration and the beneficication of nonmetallic minerals. 2R, 3L. P, 207. One field trip is required. Fee, $8.

217. Primary Casting of Metals (2) I
Staff
A detailed study of the casting of ferrous and nonferrous metals and alloys, to include pattern design, molding sand, molds, molding, and casting practice for the casting of metals. P, 218.

218.* Ferrous Production Metallurgy (2) II
Cunningham
Survey of the iron and steel industry. Study of ores; melting of iron ore; steel making and refining; wrought iron; alloy steel making in the electric furnace. P, 212.

220.* Hydrometallurgy I (2) II
Chapman
Principles of hydrometallurgy; hydrometallurgical processes used for the recovery of copper, uranium, gold, silver, and zinc from ores. P, 207.

221. Metallurgical Thermodynamics (2) I
Cunningham

222. Metallurgical Quality Control (2) I
Stubbs
A study of statistical techniques used in the metallurgical industry to reduce costs and improve quality. P, 214, or CR.

223. Hydrometallurgy (3) I
Smith
The application of chemistry, physics, and electricity to the electrowinning, electrorefining, and electroplating of metals from aqueous and fused salt electrolytic baths. Experimental work in the principles and practice of treating the common ores and concentrates by hydrometallurgical and electrometallurgical methods. 1R, 6L. P, 220. One field trip is required. Fee, $10.

224. Metallurgical Instrumentation Control (1) II
Smith
The theory and techniques of the various types of instruments used in the controlling of metallurgical products, to include, the spectrograph, spectrometer, X-ray spectrograph, spectrophotometer, fluorimeter, and other instruments used in the metallurgical industry. 3L. P, Geology 225. Fee, $5.

226. Nonferrous Production Metallurgy II (2) II
Cunningham
A study of the principles and metallurgical processes employed for the extraction of nickel, tin, mercury, antimony, bismuth, platinum, zinc, tungsten, titanium, cobalt, molybdenum and other metals from ores. P, senior standing in mining, metallurgical, or geological engineering, or chemistry.

228. Metallurgical Plant Design (2) I
Stubbs
The design of a small-capacity concentrating plant including the selection of a site, the design of a flow plan, the selection of equipment, the installation of building and equipment and estimation of capital cost and operating cost. 1R, 3L. P, 207.

231. Physical Metallurgy of Light Alloys (2) II
Anthony

232. Advanced Physical Metallurgy (2) II
Murphy
Supplementary and advanced treatment of topics introduced in 131 and 132. 1R, 3L. P, 132, 132b, Geology 225, or CR. Fee, $6.

235. Powder Metallurgy (2) I
Anthony
238. Forming and Fabrication of Metals (2) II
   The principles of melting and secondary casting, rolling, shaping, and joining of
   Walker

303. Advanced Metallurgical Thermodynamics (2) I
   P, 218, 221.
   Cunningham

306. Advanced Pyrometallurgy (2 to 4) I
   To include theory, application, and calculations that apply to zone refining, fluidizing
   reactor, processes, and other recent advances in pyrometallurgy. P, 218, 221. Fee, $3.
   Smith

307. Advanced Mineral Dressing (2 to 4) I
   To include the theory and application of recent advances in mineral dressing. P, 215,
   Fee, $3 per unit of laboratory credit.
   Staff

308. Advanced Hydrometallurgy (2 to 4) II
   Advanced work in the extraction of metals by use of solvents. Course will include
   recent research carried out by various industries. P, 223. Fee, $3 per unit of laboratory
   credit.
   Smith

309. Advanced Ferrous Production Metallurgy (2 to 4) II
   Selected topics in the production of iron, steel, and ferrous alloys including the
   physical chemistry of certain operations. P, 218.
   Cunningham

312. Light Metals Production Metallurgy (1 to 3) II
   The application of chemistry, physics, and metallurgical principles in the extraction
   of the light metals such as aluminum, magnesium, lithium, and others from ores.
   Staff

314. Utilization, Preparation, and Marketing of Fuels (1 to 3) I
   To include carbonaceous and uranium fuels. P, 215, 218, 223.
   Staff

313. Rare Metals Production Metallurgy (1 to 3) I
   The occurrences, extraction, chemical characteristics, cost, economics, and uses of
   rare metals such as platinum, iridium, germanium, beryllium, cerium, thorium, co-
   lumbium, selenium, thallium, and their alloys and compounds, P, 215, 218, and 223.
   Staff

314. Utilization, Preparation, and Marketing of Fuels (1 to 3) I
   Free electron, zone, and periodic field theories; electrical and thermal conductivity,
   Staff

332. Imperfections in Metals (2) II
   The nature and effect of imperfections in the crystal structures of metals; theories
   concerning lattice vacancies and dislocations; correlation with deformation, diffusion,
   Staff

333. X-Ray Diffraction in Metals (2) I
   Uses of Xrays in determining phase diagrams, preferred orientation, residual stress,
   Fee, $6.
   Staff

334. Physical Metallurgy Experimental Methods (1) II 1960-61
   Experimental methods used in determining data for furthering knowledge of metal
   Murphy

336. Behavior of Metals at Elevated Temperatures (2) II
   Effects of elevated temperatures on metals and alloys. Development of properties for
   high temperature service. Refractory metals. Creep and stress-rupture tests. 2R. P, 132,
   Math. 180.
   Staff

338. Theoretical Structural Metallurgy (2) II 1960-61
   Advanced treatment relating fundamental concepts of metallic structure to observed
   Staff

399a-399b. Seminar (1 to 3) I, II
   a. Extractive Metallurgy
   b. Physical Metallurgy

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (1 to 4) I, II

* Not for graduate credit for degree in metallurgical engineering.
### MINING ENGINEERING

#### 210. Mine Surveying II (3) II (May-June)
- **Staff**
- Surveying and mapping of a portion of an underground mine. The course is added to the second semester schedule but is given immediately following the close of the second semester. The equivalent of two week’s work is required at some mine in Arizona and 50 hours of laboratory work on the campus. P, 110, Civil Engineering 52. Fee, $15, which does not include room and board.

#### 214. Tunneling and Blasting (2) II
- **Dotson**
- Methods and equipment used in the construction of tunnels and aqueducts. Ventilation, dust control, and use of explosives are considered. Safety in tunneling is treated specifically. One required inspection trip to visit a mining or tunneling operation. P, junior standing in engineering. Fee, $5.

#### 220. Mine Plant Design (3) I, II
- **Drevdahl**
- The design of a modern mine plant, lectures on haulage, hoisting, compressed air distribution, draining, and mine structures. 1R, 6L. P, 104, 221, 230 or CR. One field trip. Fee, $3.

#### 221. Design of Surface Mining Systems (2) I
- **Drevdahl**
- Mining in surface excavations with emphasis on the applicability and performance of modern mobile loading and transporting equipment and cost estimating. Laboratory work in equipment output and cost problems. 1R, 3L. P, senior standing in engineering. One field trip. Fee, $3.

#### 230. Mine Examination and Valuation (2) I, II
- **Krumlauf**
- Procedure of the examination, collection of data, and valuation of mining property. P, completion of junior work in mining or geological engineering.

#### 233. Safety Engineering (2) I
- **Dotson**

#### 302. Advanced Mine Plant Design (2) II
- **Drevdahl**
- Advanced study of mine plant design. Problems are assigned dealing with materials handling, water supply, building construction, roads, utilities, communications systems, and office techniques used in producing finished design drawings and specifications. 1R, 3L. P, 220, 221, graduate standing in mining engineering.

#### 303. Mine Mechanization (2) I
- **Staff**
- A study of the development, use, and capabilities of modern mechanical equipment in underground mining. 2R. P, 221, senior or graduate standing in mining engineering.

#### 304. Mine Management (2) II
- **Krumlauf**
- A study of management problems encountered in the mining industry. 1R, 3L. P, 221, 230 or CR.

#### 305. Analysis of Mining Equipment (2) I
- **Drevdahl**
- Advanced study in the analysis of mining equipment including equipment output, costs and comparisons of the various machines under similar conditions. 1R, 3L. P, 221, 303, graduate standing in mining engineering.

#### 306. Exploitation of Industrial Minerals (2) II
- **Staff**
- The study of the mining, processing, uses, and marketing of industrial mineral products. 2R. P, 221, senior standing in mining engineering.

#### 315. Explosives Used in Mining Operations (2) I
- **Drevdahl**
- Theory, properties, and uses of commercial explosives. Application of explosives to the mineral industry will be stressed. P, senior standing in engineering. One field trip. Fee, $3.

#### 318. Mining Economics (3) II
- **Drewdahl**
- A study of the economic factors involved in the production and marketing of mine products, including the study of the fundamentals of engineering economics. 3R. P, 230, senior standing in mining engineering.

#### 321. Mine Ventilation Systems (2) I
- **Dotson**
- Mine ventilation surveys, design of airways, natural and mechanical ventilation, ventilation network calculations, temperature-humidity control, and air conditioning in mines. 1R, 3L. P, 104, senior standing in mining engineering.
322. Open-Pit Engineering and Design (2) II  
A study of some of the engineering procedures used in open-pit mining, including route surveying, road construction, railroads, earthwork calculations, ore control, and other pit engineering problems. 1R, 3L. P, 221 and senior standing in mining engineering.

326. Geomechanics I (2) II  
A study of the principles of mechanics as related to the establishment of mining openings; including the study of rock bursts. P, senior standing in mining engineering.

327. Geomechanics II (2) I  

332. Advanced Mine Valuation (2) II  
Krumlauf
Valuation of unequal income on the Hoskold redemption basis; hazards and hazard discount methods; comparison of various mine valuation formulas. 2R. P, 230.

399. Seminar (2) I  
Study of and reports on mining literature. P, senior standing in mining or geological engineering.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (1 to 4) I, II
410. Thesis (2 to 6) I, II Maximum total credit permitted, 8 units.

MUSIC


Assistant Professors Diran Akmajian, B.A., Edna E. Church, Robert A. Emile, D.M.A., Marguerite Ough, M.A.

Instructor Donald Mertz Hardisty, M.M.E.

Visiting Professor Frank Simon, Mus.D.

Graduate work is offered leading to the Master of Music degree (majors in cello, clarinet, composition, organ, piano, theory, trombone, trumpet, viola, violin, voice, and the history and literature of music), to the Master of Music Education degree, and to the Doctor of Musical Arts.

MASTER OF MUSIC

A preliminary comprehensive examination is required of all candidates for the Master of Music degree before admission to full graduate standing.

Major in Applied Music

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>Music 317</td>
<td>12</td>
</tr>
<tr>
<td>Music Theory</td>
<td>4</td>
</tr>
<tr>
<td>Music Literature or Music Education</td>
<td>6</td>
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<tr>
<td>Music Electives</td>
<td>8</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
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</tbody>
</table>

Major in Composition*

<table>
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<tr>
<th>Course</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Music 410 (Original Composition)</td>
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<tr>
<td>Applied Music</td>
<td>4</td>
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<tr>
<td>Conducting 351</td>
<td>2</td>
</tr>
<tr>
<td>Compositional Techniques 235</td>
<td>6</td>
</tr>
<tr>
<td>Music Electives</td>
<td>10</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>30</strong></td>
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</tbody>
</table>

*Indicates additional requirements for composition majors.
### Major in Theory*

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>Music 410</td>
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<tr>
<td>Music 235</td>
<td>6</td>
</tr>
<tr>
<td>Music 237</td>
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<tr>
<td>Applied Music</td>
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<tr>
<td>Music 299 or 399</td>
<td>2</td>
</tr>
<tr>
<td>Music Electives</td>
<td>12</td>
</tr>
</tbody>
</table>

#### Major in History and Literature of Music

The requirements for the Master of Music degree with a major in history and literature of music are the completion of 30 units of approved graduate study with not less than 15 units of music selected from courses in history and literature of music, theory, applied music, and thesis. The remaining units may be in music or other appropriately related subject areas.

The prerequisite for the degree is the B.A. degree with a major in music or the B.M. degree with a major in history and literature of music. A reading knowledge of German or French is required of the student before he can apply for candidacy.

### Master of Music Education

The requirements for the Master of Music Education degree are the completion of 32 units of approved graduate study with not fewer than 20 units in music and the remaining units in music or other appropriately related subject areas.

A preliminary comprehensive examination is required of all candidates for the Master of Music Education degree before admission to full graduate standing. This examination, together with personal interviews, enable the major professor to plan a program of study for the candidate which will meet both his individual interests and professional needs.

Each candidate will be required to complete ONE of the following options: a professional paper; a field study in music education; a satisfactory recital appearance; a major composition, orchestration or band arrangement; the preparation and conducting of a major work in public performance for band, orchestra, or choir.

*See page 38 for Master of Education degree major or minor in this department.*

### Doctor of Musical Arts

Programs are offered leading to the Doctor of Musical Arts with majors in composition, music education or performance. Requirements for this degree are described in detail on pages 46 ff.

### Applied Music

**Piano**
- Altman, Anthony, Church, Osta, Rebeil
  - 217-P, 218-P (1-4) I, II
  - 317-P, 318-P (3-6) I, II

**Organ**
- Buchhauser
  - 217-O, 218-O (1-4) I, II
  - 317-O, 318-O (3-6) I, II

**Voice**
- Akmajian, Bloom, Conley, Ough
  - 217-V, 218-V (1-4) I, II
  - 317-V, 318-V (3-6) I, II

**String Instruments**
- Emile, Johnson, Sammarco, Sharp

*Graduate students desiring to major in theory or composition must establish piano proficiency.*
**MUSIC**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Staff</th>
<th>Semester</th>
<th>Credits Required</th>
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</thead>
<tbody>
<tr>
<td><strong>Violin</strong></td>
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<td>217-Vn, 218-Vn (1-4) I, II</td>
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<tr>
<td>317-Vn, 318-Vn (3-6) I, II</td>
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<tr>
<td><strong>Viola</strong></td>
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<td>217-Va, 218-Va (1-4) I, II</td>
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<tr>
<td>317-Va, 318-Va (3-6) I, II</td>
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<tr>
<td><strong>Cello</strong></td>
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<td>217-C, 218-C (1-4) I, II</td>
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<tr>
<td>317-C, 318-C (3-6) I, II</td>
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<tr>
<td><strong>String Bass</strong></td>
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<tr>
<td>217-Sb, 218-Sb (1-4) I, II</td>
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<tr>
<td><strong>Wind Instruments</strong></td>
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<tr>
<td><strong>Clarinet</strong></td>
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<tr>
<td>217-CI, 218-C1 (1-4) I, II</td>
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<tr>
<td>317-CI, 318-C1 (3-6) I, II</td>
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<tr>
<td><strong>Flute</strong></td>
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<tr>
<td>217-F, 218-F (1-4) I, II</td>
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<tr>
<td><strong>Oboe</strong></td>
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<tr>
<td>217-Ob, 218-Ob (1-4) I, II</td>
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<tr>
<td><strong>Bassoon</strong></td>
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<td>217-B, 218-B (1-4) I, II</td>
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<td><strong>Saxophone</strong></td>
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<td><strong>Trumpet</strong></td>
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<td>317-T, 318-T (3-6) I, II</td>
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<td><strong>Trombone</strong></td>
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<td>317-Tr, 318-Tr (3-6) I, II</td>
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<td><strong>French Horn</strong></td>
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<td><strong>Tuba</strong></td>
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200. **Music in the Middle Ages (2) I 1960-61**
Staff: Development of music from Classical Antiquity through the Ars Nova. Religious and secular monody. The birth of polyphony. P, 106a-b, and 6 units of humanities or literature.

201. **Music in the Renaissance (2) II 1960-61**
Staff: The Burgundian School through the last Italian Madrigal. The "Golden Age" of choral polyphony. The development of instrumental music and a study of performance practices. P, 106a-b, 6 units of humanities or literature.

202. **Music of the Baroque Period (2) I 1959-60**
Staff: The age of Basso Continuo, 1580-1750, opera and oratorio, instrumental forms, keyboard music and performance practices. P, 6 units in music including la-la or 6a-6b and 6 units in literature or humanities.

203. **Music of the Classical Period (2) II 1959-60**
Staff: The period of Haydn, Mozart, and Beethoven with emphasis on the musical style and structure. P, 6 units in music including 1a-1b or 6a-6b and 6 units in literature or humanities.

204. **Music of the Romantic Period (2) I 1960-61**
Staff: The rise of Romanticism from the late Beethoven Quartets and Sonatas through the symphonies of Bruckner. P, 6 units in music including 1a-1b or 6a-6b and 6 units in literature and humanities.

205. **Music of the Twentieth Century (2) II 1960-61**
Staff: Styles and trends in contemporary music with emphasis on American composers. P, 6 units in music including 1a-1b or 6a-6b and 6 units in literature or humanities.

209. **History of the Opera (2) II 1959-60**
Staff: A detailed study of the course of opera from its inception by the Florentine Cameraata through Berg, Menotti, and Stravinsky.

220. **Principles of Music Education (3) I**
Staff: The history and philosophy of music education in the public schools with emphasis on the basic concepts needed for effective teaching in the field of music; curriculum development and evaluation of the music program. P, junior standing in music.
221. Teaching and Supervising Music in the Elementary School (3) II Staff
Nature and scope of supervision; supervisory relationships, procedures, and techniques; organization and improvement of the music curriculum; administration of the music program and development of evaluative criteria. For music majors only. P, 220.

231a-231b. Form and Analysis (2-2) Yr. Johnson
A course in the technique of harmonic and contrapuntal analysis; a study of formal design and method of structural treatment in representative scores of music from the seventeenth to the twentieth centuries. P, 33b.

232a-232b. Counterpoint I (2-2) Yr. McBride
A practical study of the sixteenth-century style of the motet and mass. P, 33b.

233a-233b. Orchestration I (2-2) Yr. Staff
A study of the instruments of the orchestra together with the practical study of the art of symphonic scoring. Original work and transcriptions. P, 33b.

235. Composition Techniques (2 to 6) I, II McBride
Creative work in the fields of modern harmony, counterpoint, and orchestration. The student may take work in any one or all of these areas. P, 33b. May be repeated for credit to a total of 10 units.

237. Band Arranging (2) II 1959-60 Lorzenhiser
Detailed study of band instrumentation; major works transcribed for concert band. P, 233a.

238a-238b. Composition I (2-2) Yr. McBride
Original work in composition, including all the primary forms; theme and variations sonatina-allegro, simple rondo and suite. P, 231a-231b or CR.

248a-248b. Composition II (2-2) Yr. McBride
Intensive work in the larger forms; variation, rondo, and sonata-allegro forms; symphonic forms. P, 238b.

255a-255b. Opera Workshop (1-1) Yr. Conley
Training in basic acting techniques for the lyric theater and operatic stage. Production and performance of opera.

271. Music for the Elementary Classroom Teacher (3) I, II Staff
An introduction to teaching music in the elementary school through a presentation of the basic concepts, skills, and procedures for teaching music to children. Laboratory period weekly devoted to building piano keyboard and other instrumental facility. Not open for credit to music majors.

272. Music Materials and Activities for the Elementary Classroom Teacher—Primary Grades (2) I, II Hartse-Sammarco
Presentation of basic materials and activities for teaching music to young children from kindergarten through third grade. Observation of demonstration teaching in music with children in the public schools. P, Music 271. Not open for credit to music majors.

273. Music Materials and Activities for the Elementary Classroom Teacher—Intermediate Grades (2) I, II Hartse-Sammarco
Presentation of basic materials and activities for teaching music to children in grades four through six. Observation of demonstration teaching in music with children in the public schools. P, 271. Not open for credit to music majors.

274a-274b. Materials and Problems in the School Music Program (2)
274a: Instrumental. II 1960-61 Lee-Johnson
274b: Choral. II 1959-60 Bloom
P, 220.

278. Marching Band Techniques (2) I 1959-60 Lee
Techniques of drilling a marching band; analysis of materials for field and street maneuvers and actual preparation of shows. P, 33b, 220.

281a-281b. Piano Pedagogy (2-2) Yr. 1960-61 Staff
Materials, methods, organization, and laboratory in preparation for teaching piano classes. P, junior standing in music.

282a-282b. Pedagogy II: A—Studio Piano; B—Studio Voice (2-2) Yr. 1959-60 Staff
Techniques of teaching individual lessons, evaluation of methods and literature, technical problems, memorization, practice procedures, studio organization, supervised practice teaching. P, junior standing in music.
310. Introduction to Musicology (3) I 1960-61  
Staff  
Bibliographical materials, problems in Medieval and Renaissance notation, performance practices, style and analysis, and criticism. P, graduate standing in music.

333a-333b. Advanced Orchestration (3-3) Yr.  
Staff  
The orchestration of large instrumental, choral, and musico-dramatic works.

351. Advanced Conducting (2) II  
Johnson  
A study of the styles of choral, band, and orchestral literature as they pertain to the problems of the conductor. References to the styles of all periods with a special emphasis on the contemporary and modern.

355. Opera Production Techniques (3) I, II  
Conley  
The theory of opera production; methods used to coordinate staging and music. Students will assist in the direction and planning as well as in the staging of scenes.

376. Modern Trends in Music Education (3) I  
Hartsell-Staff  
A presentation and discussion of modern trends relating to objectives, organization, and practices of teaching music in the public schools. P, 220 or 221, and Music 197m.

377. Music in General School Administration (3) II  
Hartsell  
Financing, scheduling, selecting personnel and equipment, supervising instruction, maintaining desirable public relations, evaluating and administering the total school music program in a school district, city, county, or state. P, 220 or 221, and Music 197m.

399. Seminar (2 to 6) I, II  
Staff

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II  
Staff

315a-315b. Problems in Applied Music and Ensembles (1) I, II  
315a: For students with graduate standing in music who wish to undertake special study problems dealing with applied music. May be repeated for credit. For fees for individual instruction in applied music see page 26.  
315b: For students with graduate standing in music who wish to participate in ensembles and pursue special study problems dealing with techniques and literature. Presentation of a critique paper required of all students registering for 315b. May be repeated for credit.

400. Research (2 to 4) I, II

410. Thesis (2 to 4) I, II  
Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

NUCLEAR ENGINEERING

Professors Lynn E. Weaver, Ph.D., Head, Merle H. Wittmeyer, M.S.

Associate Professors Ray L. Chapman, M.S., Keaton K. Keller, Ph.D., Ned Wilde, M.S.

Work leading to the degree of Master of Science with a major in nuclear engineering is offered for graduate students with a strong foundation in modern physics and mathematics. Undergraduate students contemplating graduate work in this department should elect as many nuclear engineering courses in their senior year as possible.

Supporting courses should be chosen from the fields of engineering, mathematics, physics, and chemistry.

The department's TRIGA reactor is available for laboratory work and research projects in all fields of nuclear engineering. The reactor has excellent facilities for core studies, shielding measurements and radioactive isotope production. Constant neutron flux is 10^{12} neutrons per square centimeter per second and a flux of 10^{15} is available in fractional second pulses.
210. **Introductory Health Physics (3) I, II**  
**Staff**  
A survey course for those students in chemistry and the life sciences who intend to use radiation or radioisotopes as tools, and who must therefore be literate in the field of health physics. Topics will include radioactivity, the interaction of radiation with matter, radiological measuring units, dosimetry, and the tolerance concept. The application and use of health physics instruments for making environment measurements will be discussed and demonstrated. (Not for nuclear engineers.) P, Phys. 10b or 130b.

211. **Health Physics Laboratory (2) I, II**  
**Staff**  
This laboratory is designed to demonstrate the use of radiological measuring instruments and to give the student experience with Geiger counters, proportional counters, scintillation counters, scalers, ionization chambers, scintillation spectrometry, X-ray calibration, air sampling techniques, and radiation survey procedures. 1R, 3L. P, 210. Fee, $5.

221. **Experimental Nuclear Engineering I (3) I, II**  
**Staff**  
Introduction to experimental nuclear engineering methods. 2R, 3L. P, Phys. 130b. Fee, $5.

223. **Experimental Nuclear Engineering II (3) I, II**  
**Staff**  
Continuation of 221 to include advanced experimental techniques. 2R, 3L. P, 221. Fee, $5.

240. **Nuclear Power Sources (3) I, II**  
**Wittmeyer**  

260. **Materials in Radiation Fields (3) I, II**  
**Keller**  
Study of the effects of radiation fields on materials, and the control and utilization of these effects. P, Phys. 130b.

280. **Analytical Methods of Nuclear Radiation (3) I, II**  
**Wilde**  
An engineering analysis of the external properties of nuclear radiation sources, nuclear radiation fields, and the mathematical relationship between them. The course will include applications of analytical methods of practical problems. P, Phys. 130b.

340. **Reactor Theory I (3) I, II**  
**Chapman**  
Utilization of particle mechanics in determining reactor composition and configuration. P, 240 or CR.

342. **Reactor Theory II (3) I, II**  
**Chapman**  
Continuation of 340 to include reactor kinetics, power removal and reactor control. P, 340.

350. **Health Physics (3) I, II**  
**Staff**  
This course is intended to provide the basic principles for the understanding of radiation safety for students with a major interest in the field. Topics will include physical dosimetry, biological effects on radiation, the tolerance concept as applied to individuals and to populations, and the biophysical basis for tolerance values. The principles of radiation protection will be illustrated throughout the course with design problems in shielding, dosimetry, ventilation, waste disposal, and related matters. P, 260.

352. **Reactor Hazards Evaluation (3) II**  
**Staff**  
The safety aspects of the reactor, its controls, and its maintenance, will be discussed. The problems in site selection, including hydrology, geology, and meteorology, as well as the possible consequences of a theoretical disaster will be considered. A major portion of the classroom time will be devoted to a detailed review of hazard reports on several different types of reactors. P, 240, 350.

380. **Information Perception and Nuclear Radiation (3) I, II**  
**Wilde**  

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**INDIVIDUAL STUDIES**

299. **Special Problems (2 to 5) I, II**

400. **Research (2 to 5) I, II**

410. **Thesis (3 to 8) I, II**  
Maximum total credit permitted, 8 units.
NUMERICAL ANALYSIS

Professor A. Wayne Wymore, Ph.D., Head
Assistant Professor K. Stanley Gale, M.A.
Instructor Donald A. Freedman, M.S.

No advanced degree is offered in numerical analysis. The courses listed below may be included in graduate study programs approved by other departments.

240. Operations Analysis (3) I  Staff
Principles and illustrations of solution of business and industrial problems using the methodology of operations research; use of mathematical models and their interpretation as aids in making executive decisions will be discussed. CR, Math. 290 or 291.

241. Advanced Operations Analysis (3) II Staff
This course is a continuation of 240 and includes a critical discussion of game, decision, and information theory, mathematical programming, models, and numerical simulation as applied to problems in operations research. P, 240.

270. Data Processing and Reduction (3) I, II Staff
Basic principles of information handling and automatic computation. Use of punched-card equipment: the card punch, verifier, sorter, reproducer, accounting machine, and so on. Business applications and implications. Flow charts and block diagrams. Coding, programming, and operating a computer, with particular reference to the IBM Type 630 Magnetic Drum Data Computer. The role of the computer in scientific management. 2R, 3L. Fee, $5.

271. Advanced Data Processing Reduction (3) II Staff
This course is a continuation of 270. Topics included are advanced programming techniques, systems analysis, feasibility studies, applicable techniques of operations research, survey of small, intermediate, and large scale computers, integrated systems for the collection, tranmission, processing, and recording of information, case studies of business data-processing problems.

272. Electronic Analog Computers (3) I, II Korn
(Identical with EE 272)

273. Basic Analog-Computer Laboratory (1) I, II Korn
(Identical with EE 273)

274. Elements of Machine Logic (3) II Staff
(Identical with EE 274)

275. Numerical Analysis (3) I Wymore
Introduction to numerical analysis with emphasis on the underlying mathematical concepts. Included will be topics in the categories of error analysis, solution of systems of linear and non-linear equations, approximation theory, and numerical solution of ordinary and partial differential equations. P, Math. 180.

276. Advanced Numerical Analysis (3) II Wymore
This course is a continuation of 275. Work begun in 275 will be expanded and special topics in numerical evaluation of multiple integrals, relaxation methods, Monte Carlo methods of Tchebysheff approximations will be included. P, 275. Fee, $5.

277. Programming Digital Computers (3) I, II Staff
Characteristics of punched-card systems and electronic computers from the programmer's viewpoint (as distinguished from the designer's viewpoint). Machine logic, numerical methods, and programming principles necessary to program typical scientific and commercial problems will be given. The formal lectures will be illustrated through exercises in the laboratory sessions on the IBM Type 630 Magnetic Drum Computer. 3L, 2R. P, Math. 20. Fee, $5.

278. Advanced Programming Digital Computers (3) II Staff
This course is a continuation of 277. Advanced programming techniques will be discussed with special emphasis on abstract and symbolic coding, subroutine design and organization, assembly routines, automatic coding systems, compilers, and interpretive routines. Application to modern large-scale computers will be given with detailed study of the IBM Type 709. P, 277. Fee, $5.

399. Seminar (1 to 6) I, II
INDIVIDUAL STUDIES

299. Special Problems (1 to 6) I, II

400. Research (1 to 6) I, II

NURSING

Professors Pearl P. Coulter, M.S., Director, School of Nursing, Ruth C. Hall, Ph.D., Director, School of Home Economics.

No advanced degree in nursing is offered. The courses listed below may be included in graduate study programs approved by other departments.

200. Child Development and Family Life (2) Coulter-Hall
For pediatrics and public health nurses, including school nurses, as well as for home economics teachers and other home economists interested in child development. For others by special permission.

202. Rehabilitation and Work Simplification (1) Coulter-Hall
An investigation of the resources locally available for the assistance of the handicapped. Work-simplification methods and techniques for disabled persons in the home. Designed for home economists, nurses, and others working with the handicapped. Fee, $5.

NUTRITION
(See Agricultural Biochemistry)

ORIENTAL STUDIES

Professors Charles O. Hucker, Ph.D., Chairman, Andreas S. Andersen (Art), Lauren W. Casaday, Ph.D. (Economics), Edward H. Spicer, Ph.D. (Anthropology)

Associate Professor Herman E. Batemen, Ph.D. (History)

Lecturer James M. Mahar, B.A.

The program in oriental studies aims at an interdisciplinary understanding of the civilizations of Asia: Islamic, Indic, Southeast Asian, Chinese, Korean, and Japanese. The undergraduate curriculum includes courses in such disciplines as anthropology, art history, geography, government, history, language and literature, philosophy, and sociology.

No advanced degree in oriental studies is offered. The courses listed below may be included in graduate study programs approved by other departments. Interested students are also referred to related courses in the Departments of Anthropology, Art, Business Administration, Government, and History.

201. Chinese Literature in Translation (2) II 1960-61 Hucker
The evolution of literary forms and styles in China, with representative readings in poetry, artistic prose drama, short stories and novels.

202. Chinese Thought (2) I 1960-61 Hucker
The traditional ideological system of China, especially Confucianism and Taoism, and their evolutionary transformations.
(Identical with Philosophy 202)

211. Literature of India (2) II Mahar
A survey of Indian prose, poetry, and drama. Selected readings range from Vedic poetry to contemporary novels.

212. Hindu Thought (2) I Mahar
The traditional religious, philosophical, and political thought of India.
(Identical with Philosophy 212)
221. Japanese Literature in Translation (2) I 1960-61 Staff
The evolution of literary forms and styles in Japan, with representative selections of poetry, artistic prose, drama, short stories, and novels.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II Staff
The courses listed below are recommended for students who are interested in Oriental studies and may be taken for Oriental studies credit in major and minor programs. For descriptions of the courses, see listings under the respective departments.

ANTHROPOLOGY 201a-201b. Introduction to Indic Civilization (3-3) Yr. Mahar
ANTHROPOLOGY 210. Introduction to Southeast Asia (3) I Hackenberg
ANTHROPOLOGY 211. Contemporary Southeast Asia (3) II Hackenberg
ANTHROPOLOGY 286. Culture Patterns of Japan (2) I 1959-60 Hulse
ART 215. Far Eastern Art (3) I 1960-61 Quinn
ART 216. Islamic Art (3) II 1960-61 Quinn
BUSINESS ADMINISTRATION 210a-210b. Area Surveys (2-2) Yr. Staff
BUSINESS ADMINISTRATION 217b. Arid Lands of the World (The Middle East) (2) II 1959-60 Wilson
GOVERNMENT 240. Government in the Far East (3) I Hucker
GOVERNMENT 241. Government in South Asia (3) II Mahar
HISTORY 272. Muslim World (3) II Oswald
HISTORY 275a-275b. History of China (3-3) Yr. Hucker
HISTORY 277a-277b. History of Japan (3-3) Yr. Staff Hucker
HISTORY 339D. Seminar (Oriental History) (2) II Hucker

PHARMACY

Professors Willis R. Brewer, Ph.D., Dean, Rex V. Call, Ph.D., Albert L. Picchioni, Ph.D., Vartkes H. Simonian, Ph.D., Joseph A. Zapotocky, Ph.D.

Associate Professor Jack R. Cole, Ph.D.
Assistant Professor Lincoln Chin, Ph.D.

Graduate study opportunities available in the field of pharmacy include:

The Master of Science degree program with courses selected to provide for specialization in general pharmacy (including hospital pharmacy), pharmaceutical chemistry, pharmacognosy, pharmacology, and pharmacy administration.

The Doctor of Philosophy program with courses selected to provide for specialization in pharmaceutical chemistry, pharmacognosy and pharmacology.

Acceptable minor field courses and electives may be found in areas of pharmacy specialization not undertaken in the major or in selected offerings in anatomy, botany, business administration, chemistry, engineering, microbiology, nutrition, physiology, and zoology.

Graduation with the degree of Bachelor of Science in Pharmacy or its equivalent with high standing from a school or college of pharmacy accredited by the American Council on Pharmaceutical Education is prerequisite to graduate study in the College of Pharmacy. Further, the candidate may be required to pass a comprehensive qualifying examination administered by the graduate teaching members of the pharmacy faculty. Additional requirements for doctoral studies include mathematics through calculus in all three areas of specialization, and in introductory statistics course in the biological science areas, pharmacognosy, and pharmacology. Students may be accepted conditionally when deficiencies can be removed during the first year of graduate study.
Special facilities of the College of Pharmacy available for graduate study include animal, plant, and chemical science laboratories; a manufacturing laboratory; a medicinal plant garden and greenhouse; an animal colony; a distillation and extraction unit; numerous mechanical, optical, and electronic instruments for research purposes; and a reference library.

Note: A laboratory breakage deposit of $2.50 is required for all courses for which a course fee is noted below.

207a-207b. Organic Pharmaceutical Chemistry (4-4) Yr. Zapotocky
A study of the chemical structure and physiological activity, sources, production methods, properties, reactions, tests, incompatibilities, and stability of the organic chemicals used in pharmacy. P, 100, Chemistry 140b.

221a-221b. General Pharmacognosy (4-4) Yr. Simonian
A study of the drugs of biological origin, their active ingredients, their preparation, and their derived products. 3R, 3L, P, 52, Botany 1, Chemistry 140b. Fee, $10 each semester.

231a-231b. General Pharmacology (5-5) Yr. Picchioni-Chin
A study of pharmacodynamic actions, therapeutic applications, and toxicology of drugs and poisons. 4R, 3L, P, 207b, 221b, Chemistry 260a, Zoology 253b. Fee, $10 each semester.

318. Pharmaceutical Manufacturing (3) II 1960-61 Cole-Childs
A study and practice of procedures used in pharmaceutical manufacturing, employing pilot-scale equipment and unit operations such as granulation, compression, coating, sterilization, levigation, and filtration. Each student is required to develop and manufacture one selected dosage form. 1R, 6L, P, 110b or CR. Fee, $10.

321a-321b. Advanced Pharmacognosy (4-4) Yr. 1959-60 Simonian
A technical study of the origins and techniques of pharmacognostic evaluation of drugs of plant and animal sources. 3R, 3L, P, 221b. Fee, $10 each semester.

322. Drug-Plant Products and Principles (2) I 1960-61 Simonian
A study of the properties of medicinally important products and active principles of plant origin. P, Chemistry 140b.

324. Antibiotics (2) I 1960-61 Simonian
Principles of antibiotic chemotherapy and the properties of the natural antibiotics employed in therapeutics and growth control. P, 221b, Bact. 117a or equivalents.

332. Biological Assays (4) I 1960-61 Picchioni-Chin
A study of the quantitative standardization of drugs by biological procedures. 2R, 6L, P, 231b or CR. Fee, $10.

340R. Advanced Pharmacology (2) I 1959-60 Picchioni-Chin

340L. Advanced Pharmacology Laboratory (2) I 1959-60 Picchioni-Chin
Laboratory exercises for 340R. 6L, P, 231b, 340R or CR. Fee, $10.

342. Pharmacological Methods (4) II 1960-61 Picchioni-Chin
A study of biological methods used to evaluate synthetic and natural compounds for pharmacodynamic and potential pharmacotherapeutic actions. 2R, 6L, P, 231a-231b or CR.

350R. Advanced Toxicology (3) II 1959-60 Staff
A study of the action, methods of detoxication, and detection of some of the more potent medicinal agents with special reference to those found in the United States Pharmacopeia, National Formulary, and New and Nonofficial Drugs. P, 207b, 221b or CR.

350L. Advanced Toxicology Laboratory (1) II 1959-60 Staff
Laboratory exercises for 350R. 3L, P, 350R or CR. Fee, $10.

370a-370b. Advanced Pharmaceutical Chemistry—Synthetic Organic Medicinals (3-3) Yr. 1959-60 Cole
A study of the synthetic preparation, properties, and relationship between structure and physiological action of the neurotropic and local anesthetic drugs in the first semester and the antibacterial and antimitochondrial drugs in the second semester. P, 207b, 231b.
372Ra-372Rb. Advanced Pharmaceutical Chemistry—Natural Medicinal Products (3-3) Yr. 1960-61 Zapotocky-Cole
A study of the origin, isolation, and properties of fat, volatile oil, wax, steroid, and vitamin drugs in the first semester (Zapotocky) and the carbohydrate, glycoside, and alkaloid drugs in the second semester (Cole). P, 207b, 231b.

372La-372Lb. Advanced Pharmaceutical Chemistry Laboratory (2-2) Yr. 1960-61 Zapotocky-Cole
Laboratory exercises for 372Ra-372Rb. 6L. P, 207b, 231b, 372Ra-372Rb or CR. Fee, $10 each semester.

380. Technical Microscopy of Natural Products (4) II 1960-61 Simonian
Microscopic study of type representations of drugs, foods, cosmetics, condiments, starches, and fibers used in industry with emphasis on detection and measurement of adulterants and additives found in commerce. 2R, 6L. P, 221b or equivalent. Fee, $10.

399. Seminar (1) I, II Staff
Reviews of current pharmaceutical literature and presentations on fields of special interest and research. Required of all graduate students. Attendance open to any one interested in the health sciences by contacting the dean of the College of Pharmacy.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
Special problems in pharmacy, pharmaceutical chemistry, pharmacology, pharmaco-, cognosy, or pharmacy administration. Fee, $5.

400. Research (1 to 5) I, II

410. Thesis (1 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

PHILOSOPHY AND PSYCHOLOGY

Professors Neil R. Bartlett, Ph.D., Head, Ole A. Simley, Ph.D., Charles F. Wallraff, Ph.D.

Associate Professors Robert W. Bretall, Ph.D., Robert H. Hurlburt, Ph.D., Ralph C. Kauffman, Ph.D., Dorothy E. Marquart, Ph.D., Arnold Meadow, Ph.D.

Assistant Professors Richard W. Coan, Ph.D., Lewis Hertz, Ph.D., Robert W. Lansing, Ph.D., William J. MacKinnon, Ph.D.

Instructors Robert L. Caldwell, Ph.D., Joseph L. Cowan, Ph.D., Salvatore V. Zagona, M.A.

The department offers graduate work leading to the degree of Master of Arts in philosophy and to the degrees of Master of Arts and Doctor of Philosophy in psychology.

PHILOSOPHY

Persons seeking admission to graduate work in philosophy must have completed 24 semester hours in addition to Introduction to Philosophy. Graduate work in philosophy revolves around a central core of basic study, including logic, history of philosophy, ethics, esthetics, metaphysics, and epistemology. A minor subject should be selected from the following fields: history, literature, mathematics, physical and biological sciences, psychology, and social sciences. Candidates accepted for graduate work in philosophy may be required, at the option of the department, to submit to an examination in the core subjects listed above. This examination, if required, will be held early in the first semester of graduate work. Deficiencies in undergraduate preparation must be made up by taking the necessary courses without graduate credit.

The Degree of Master of Arts in Philosophy. — The work normally will consist of a minimum of 30 semester units, to include not more than eight units for the thesis. At least 15 units other than the thesis must be in philosophy.
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<th>Course Number</th>
<th>Course Title</th>
<th>Instructor</th>
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<tr>
<td>202</td>
<td>Chinese Thought (2) I 1960-61</td>
<td>Hucker</td>
<td>(Identical with Oriental Studies 202)</td>
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<td>205</td>
<td>Philosophy of Science (3) I</td>
<td>Cowan</td>
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<td>An examination of concepts and methods of the</td>
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<td>formal and empirical sciences, and</td>
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<td>of interrelations between the different</td>
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<td>sciences, science and other disciplines, and</td>
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<td>science and society. P, 6 units of philosophy</td>
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<td></td>
<td>or 12 units of natural science, social science,</td>
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<td></td>
<td>or mathematics.</td>
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<tr>
<td>212</td>
<td>Hindu Thought (2) I</td>
<td>Mahar</td>
<td>(Identical with Oriental Studies 212)</td>
</tr>
<tr>
<td>220</td>
<td>Ethics (3) I</td>
<td>Bretall</td>
<td></td>
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<tr>
<td></td>
<td>The meaning of moral values and responsibility;</td>
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<td></td>
<td>a critical study of historical philosophies of</td>
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<td></td>
<td>life. P, 3 units in philosophy other than</td>
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<td></td>
<td>12a-12b.</td>
<td></td>
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<tr>
<td>221</td>
<td>Religious Ethics (3) II 1960-61</td>
<td>Bretall</td>
<td></td>
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<tr>
<td></td>
<td>A study of the ethical content of the major</td>
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<td></td>
<td>world religions with emphasis on the</td>
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<td></td>
<td>Judaeo-Christian tradition. The philosophical</td>
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<td></td>
<td>interpretations of the ethical aspects of</td>
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<tr>
<td>228</td>
<td>Principles of Esthetics (3) I</td>
<td>Hurlbutt</td>
<td></td>
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<tr>
<td></td>
<td>The nature and value of the arts; principles</td>
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<td></td>
<td>and media of expression. P, 6 units in</td>
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<td></td>
<td>philosophy other than 12a-12b, or 6 upper-</td>
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<tr>
<td></td>
<td>division units in the history of art.</td>
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<tr>
<td>230</td>
<td>American Philosophy (3) II 1959-60</td>
<td>Wallraff</td>
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<tr>
<td></td>
<td>The main currents of contemporary American</td>
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<td>philosophical thought, their developmental</td>
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<td></td>
<td>history, and relation to social and cultural</td>
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<td></td>
<td>processes. P, 6 upper-division units in</td>
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<td></td>
<td>philosophy.</td>
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<tr>
<td>231</td>
<td>Metaphysics (3) I 1959-60</td>
<td>Wallraff</td>
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<tr>
<td></td>
<td>The nature and function of metaphysical</td>
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<td></td>
<td>speculation; survey and criticism of</td>
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<td></td>
<td>recurrent metaphysical systems. P, 6 upper-</td>
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<td></td>
<td>division units in philosophy.</td>
<td></td>
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<tr>
<td>232</td>
<td>Epistemology (3) I</td>
<td>Caldwell</td>
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<tr>
<td></td>
<td>Critical examination of the major problems</td>
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<td></td>
<td>involved in theory of knowledge; study of</td>
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<td>classical and contemporary viewpoints; relation</td>
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<td>of theory of knowledge to the other principal</td>
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<td></td>
<td>divisions of philosophy. P, 6 upper-division</td>
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<td></td>
<td>units in Philosophy.</td>
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<tr>
<td>233</td>
<td>Philosophies of Religion (3) I</td>
<td>Bretall</td>
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<tr>
<td></td>
<td>Critical considerations of prevailing points</td>
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<td></td>
<td>of view in occidental religious philosophy.</td>
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<td></td>
<td>P, 6 upper-division units in philosophy.</td>
<td></td>
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<tr>
<td>234</td>
<td>Social Philosophies (3) II 1960-61</td>
<td>Wallraff</td>
<td></td>
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<tr>
<td></td>
<td>Contemporary social and political movements in</td>
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<td></td>
<td>the light of human values involved. P, 6 units</td>
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<td></td>
<td>in philosophy other than 12a-12b and 228, and</td>
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<tr>
<td></td>
<td>6 units in anthropology, economics, history,</td>
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<td>political science, or sociology.</td>
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<td>235</td>
<td>Religion and Cultures (3) II</td>
<td>Bretall</td>
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<tr>
<td></td>
<td>Cultural forms as expression of religious</td>
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<td>concern; religion as expression and critique</td>
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<td></td>
<td>of culture, especially in the Judaeo-Christian</td>
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<td></td>
<td>tradition. P, 20a-20b or equivalent, and</td>
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<td>1 additional course in philosophy. Open to</td>
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<td></td>
<td>anthropology majors without prerequisites</td>
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<td></td>
<td>in philosophy.</td>
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<td>236</td>
<td>Idealism (3) I 1960-61</td>
<td>Wallraff</td>
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<tr>
<td></td>
<td>A critical study of post-Kantian idealism, with</td>
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<td></td>
<td>especial reference to the epistemology and</td>
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<td></td>
<td>metaphysics of the British idealists. P, 6</td>
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<tr>
<td></td>
<td>upper-division units in philosophy.</td>
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<td>237</td>
<td>Naturalism (3) I</td>
<td>Hurlbutt</td>
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<tr>
<td></td>
<td>A survey of the main materialistic and</td>
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<td>naturalistic philosophies from Democritus to</td>
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<td>modern times. The relationships between these</td>
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<td>philosophies and the development of modern</td>
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<tr>
<td>238</td>
<td>Philosophical Poets (3) II</td>
<td>Bretall</td>
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<tr>
<td></td>
<td>Philosophical analysis of selected poetic</td>
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<td></td>
<td>works. P, 11a-11b, or 6 units of literature.</td>
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<tr>
<td>239</td>
<td>Ideological Differences and Behavioral Science  (2) II</td>
<td>MacKinnon</td>
<td></td>
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<tr>
<td></td>
<td>(Identical with Psychology)</td>
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<tr>
<td>240</td>
<td>Philosophy of History (3) II 1959-60</td>
<td>Hurlbutt</td>
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<td></td>
<td>A survey of the basic concepts of the major</td>
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<td>philosophies of history from ancient</td>
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<td></td>
<td>to modern times. P, 6 units in philosophy or</td>
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<td></td>
<td>in upper-division history.</td>
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<tr>
<td>335</td>
<td>Contemporary Philosophy (3) II 1960-61</td>
<td>Cowan</td>
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<tr>
<td></td>
<td>Principal philosophical tendencies in Europe</td>
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<td></td>
<td>and America since 1866; the relation</td>
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<td>between philosophical writings and world</td>
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</table>
PHILOSOPHY AND PSYCHOLOGY

399. **Seminar (2) I, II**  
Staff  
Subject matter to be determined in consultation with the members of the class. Open to seniors. P, 101a-101b and 3 additional units in philosophy.

**INDIVIDUAL STUDIES**

299. **Special Problems (2 to 3) I, II**

400. **Research (1 to 3) I, II**

410. **Thesis (1 to 4) I, II** Maximum total credit permitted, 8 units.

**PSYCHOLOGY**

Persons seeking admission to graduate work in psychology should have completed 24 semester hours in addition to elementary psychology. Graduate work revolves around a central core of basic study including the experimental, physiological, social, research design, personality, clinical and developmental fields, with specialization during the terminal phase of the doctoral program. A minor subject should be selected from the following fields: anthropology, sociology, speech, personnel, biology, physics or mathematics. Deficiencies in undergraduate preparation must be made up by taking the necessary courses without graduate credit.

*The Degree of Master of Arts in Psychology.*—The work will consist normally of a minimum of 30 semester units, to include not more than eight units for the thesis. At least 15 units other than the thesis must be in psychology.

*The Degree of Doctor of Philosophy in Psychology.*—The requirements for this degree are given on page 42. The final examination will be both written and oral.

203. **Physiological Psychology (3) I**  
Lansing  
Psychological processes and their relation to bodily structures and functions. P, 1a and 4 additional units in biological laboratory science.

210. **The Individual in the Group (3) I, II**  
MacKinnon  
The psychological effects of membership and non-membership in group situations. P, 6 units of sociology may be substituted for Psychology 1a-1b.

211. **Comparative Psychology (3) I**  
Simley  
Historical and systematic study of animal behavior; sensory functions, learning, and intelligence compared with corresponding functions in human beings. 2R, 3L. Fee, $2.

213. **Genetic Psychology—Childhood (3) II**  
Marquart  
The child from conception to adolescence with emphasis upon experimental analysis of the development of behavior.

216. **Personality (3) II**  
Coan  
Theories of personality; methods and results of personality study.

217. **Motivation (3) II**  
Simley  
The functioning of native and acquired drives in behavior.

218. **Abnormal Psychology (3) I, II**  
Simley  
A study of the nature and etiology of the various forms of behavior disorder, mental deficiency, and other deviations. A critical evaluation of current theories. Fee, $5.

239. **Ideological Differences and Behavioral Science (2) I**  
MacKinnon  
The relations between human value-systems and behavioral principles; the prospects for a common ideology. P, 6 units of philosophy may be substituted for Psychology 1a-1b.  
(Identical with Philosophy 239)

250. **Tests and Measurements (3) I, II**  
Hertz-Zagona  
Theory, uses, and construction of tests. Intelligence, special aptitudes, performance, personality, and interest devices will be evaluated. 2R, 3L. P, Business Administration 135, Education 254, or Mathematics 91 or 291a-291b, or CR in any one of these courses. Fee, $5.
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Instructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>253</td>
<td>Group Dynamics (3)</td>
<td>Mulligan</td>
<td>(Identical with Sociology 253)</td>
</tr>
<tr>
<td>257</td>
<td>Neurology (4)</td>
<td>McCauley</td>
<td>(Identical with Zoology 257)</td>
</tr>
<tr>
<td>275</td>
<td>History of Psychology (3)</td>
<td>Bartlett</td>
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<tr>
<td>290</td>
<td>Thought and Imagination (3)</td>
<td>Marquart</td>
<td>Concept formation, reasoning, and other thought processes viewed from an experimental and theoretical approach. P, 125a-b or equivalent.</td>
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<tr>
<td>302</td>
<td>Diagnostic Techniques in Psychology (3)</td>
<td>Meadow</td>
<td>The integrative application of various psychodiagnostic methods. Special attention will be given to diagnostic interviewing and to non-projective measures. P, 252, 303, and either 304 or CR.</td>
</tr>
<tr>
<td>303</td>
<td>Projective Techniques I (3)</td>
<td>Coan</td>
<td>Theoretical principles and practice in the use of the Rorschach and other projective techniques. P, 501 or CR.</td>
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<tr>
<td>305</td>
<td>Design, Measurement, and Analysis in Psychological</td>
<td>MacKinnon</td>
<td>Research (3)</td>
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<td></td>
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<td>Primarily a theory course, with practice in planning experiments in selected areas. P, a course in statistics, preferably Mathematics 91, and a laboratory course in experimental psychology.</td>
</tr>
<tr>
<td>309</td>
<td>Factor Analysis (3)</td>
<td>Coan</td>
<td>Introduction to factor analytic procedures; the purposes, methods, and significance of the results obtained. P, 250.</td>
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<tr>
<td>310</td>
<td>The Exceptional Child (3)</td>
<td>Staff</td>
<td>Characteristics and adjustment problems of exceptional children. P, 218.</td>
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<tr>
<td>311</td>
<td>Theories of Learning (3)</td>
<td>Lansing</td>
<td>Exposition and analysis of systematic conceptions of the learning process. P, 125a-125b.</td>
</tr>
<tr>
<td>312</td>
<td>Seminar in the Psychology of Interpersonal</td>
<td>MacKinnon</td>
<td>Relations (2)</td>
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<td>Theoretical and practical aspects of psychological relations between individuals. P, 24 units of upper-division instruction in psychology.</td>
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<tr>
<td>315</td>
<td>Personality and Human Values (2)</td>
<td>MacKinnon</td>
<td>The reciprocal influence of personality and social ideals. P, 24 units in upper-division instruction in psychology.</td>
</tr>
<tr>
<td>316</td>
<td>Seminar in Personality Theory (3)</td>
<td>Coan</td>
<td>Consideration of basic problems of theory construction with application to theoretical systems in the personality area. P, 216 and 24 units of upper-division instruction in psychology.</td>
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<tr>
<td>318</td>
<td>Experimental Approaches to the Personality and</td>
<td>Coan</td>
<td>Clinical Fields (3)</td>
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<td>Evaluation of current research and problems relating to personality processes and personality structures. P, 216 and 125a-125b and 24 units of upper-division instruction in psychology.</td>
</tr>
</tbody>
</table>
320. Physiological Foundations of Behavior (3) II  Lansing
  Analysis of electrophysiological and hormonal data pertinent to perception and learning. P, 203 or equivalent, and 24 units of upper-division instruction in psychology or biology.

321. Emotion (3) II 1959-60  Lansing
  Dimensions of emotion, physiological basis of emotional activity, and relationship to learning and other performance. P, 203 or equivalent and 24 units of upper-division instruction in psychology or biology.

322. Conditioning and Behavior (3) II 1960-61  Lansing
  Problems of instinctive and learned behavior treated in the light of data of Pavlovian (respondent) and operant conditioning and imprinting. P, 24 units of upper-division instruction in psychology or biology.

323. The Lower Senses (3) I 1960-61  Lansing
  Analysis of communication through sensory channels other than vision and audition. P, 24 units of upper-division instruction in psychology, biology or engineering.

325. Critical Review of Selected Major Experiments (3) Marquart
  Exposition and demonstrations, with repetitions of some phases of important experiments in perception and learning. 2R, 3L. P, a course in statistics. (Credit may not be given to students who have completed Psychology 125a-125b or equivalent.)

326. Vision (3) I 1959-60  Bartlett
  Analysis of the receptive processes involved in such visual functions as dark-adaptation, acuity, and color discrimination and a treatment of basic perceptual data and theory. P, 24 units of upper-division instruction in psychology or biology.

330. Human Factors in Work (3) I 1960-61  Bartlett
  Selected topics related to information displays and mechanical controls and to the human factors in equipments and systems. P, 24 units of upper-division instruction in psychology, biology, or engineering.

390. Psychology Colloquium (1). I, II  Staff
  A weekly meeting for discussion of research problems by staff, graduate students, and, on occasion, by visiting scholars. Required of students registered for 400, 410, or 420. P, 24 units of upper-division instruction in psychology.

395. Practicum in Diagnostic Techniques (2) I, II  Staff
  Practice in clinical evaluation. P, 302 or CR therein. (May be taken twice for credit.)

INDIVIDUAL STUDIES

299. Special Problems (2 to 3) I, II

400. Research (1 to 3) I, II

410. Thesis (1 to 4) I, II  Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

PHYSICAL EDUCATION FOR MEN

Professors Marion R. Clausen, M.S., Director, Fred A. Enke, B.S., Frank T. Gibbings, B.S., James LaRue, M.S., Joseph L. Picard, M.S., Frank Sancet, B.S.

Associate Professors Carl W. Cooper, M.S., Charles H. Ott, M.S., Robert S. Svob, M.S.


The Department of Physical Education offers a major for the Master of Education degree. Graduate courses in both the Department of Physical Education for Men and the Department of Physical Education for Women are available for this purpose.

See page 38 for Master of Education degree major or minor in this department.

282. Supervision and Administration of Intramural Sports (2) II  Coopwood
  The nature of intramural sports; their organization for units of competition, program content, scoring systems, awards, officiating, physical facilities, purposes, and special administrative problems. Open to both men and women.
285. Measurement and Evaluation in Health and Physical Education (2) I  
Roby  
Survey of literature and standardized tests. Criteria for determining student progress, techniques, and devices for measuring facilities and programs in terms of objectives sought. P, 6 units of physical education and 6 units of education to include Education 257.

287. Kinesiology (2) I  
Tatum  
Study of the origin, insertion, and function of musculature and its application to skill training, activity for the physically handicapped, and use in training-room techniques. P, Zoology 1, 40, 57. Fee, $3.

289. Elementary School Physical Education (2) I  
Roby  
Methods of planning, organizing, and directing a modern physical education program in the elementary school. P, 6 units of physical education and 6 units of education.

293. Remedial and Corrective Physical Education (3) II  
Ott  

297. Organization and Administration of Physical Education (3) I  
Enke  
A study of the administrative problems involving athletic plant facilities and equipment, conduct of interscholastic athletics and tournament competition; maintenance of public relations; the office management and financing of physical education and athletics. Open to men and women. P, 12 units of physical education, 9 units of education, and, for graduate credit, teaching experience.

INDIVIDUAL STUDIES

299. Special Problems (1-3) I, II  
Roby-Staff

RELATED COURSES IN RECREATION

273. School Camping (2) II 1960-61  
Staff  
Purposes of educational training conducted in day and resident school camps. Special consideration of organizational curricular, administrative, and supervisory provisions in the conduct of a school camp. P, 6 units in recreation including 171, 6 units in education. Field trip, fee, $4.

275. Recreational Activities, Materials, and Methods (2) I 1960-61  
Ott-Staff  
Materials and methods for conducting music, arts and crafts, dramatics, dancing, social events, and hiking in camping. Conservation of natural resources. Personal safety precautions. P, 6 units in education, 6 units in recreation including 171.

283. Administration of Recreation (2) II  
Ott-Staff  
Administration of tax-supported recreation. Financing, responsibilities, legalities, area selection, design and facilities, personnel selection, public relations, using community resources. P, 6 units in education, 6 units in recreation including 171, P.E. 162.

PHYSICAL EDUCATION FOR WOMEN

Professor Mary Pilgrim, M.A., Director  
Assistant Professor Betty J. Hileman, M.A.  
Instructor Ethel Johnson, M.A.

The department offers a major and minor in physical education for the Master of Education degree. Graduate courses in both the Department of Physical Education for Women and the Department of Physical Education for Men are available for this purpose.

See page 38 for Master of Education degree major or minor in this department.

252. Health Programs, Problems, and Applied Physiology (3) I 1960-61  
Johnson  
Social, economic, and educational influences on health; principles and procedures in conducting a health program. The application of human physiology to problems of physical education. Open to men and women. P, Zoology 1a, 40.
258. History and Principles of Physical Education (3) II
   Staff
   Integration of philosophies, principles, and objectives; the development of physical education from ancient societies to the 20th century; emphasis on educational philosophies of each era and their influence on current practices. Open to men and women.

264. Supervision of Play and Playgrounds (3) II
   Johnson
   Theories of play, methods of organization, administration, and management of playgrounds; discussion of equipment; study of methods of training playground supervisors and leaders.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 6) I, II

The Teaching of Physical Education for Women (3) I

See Education 197n.

PHYSICS

Professors Albert B. Weaver, Ph.D., Head, Leon Blitzer, Ph.D., R. W. G. Wyckoff, Ph.D.

Associate Professors Arthur A. Evett, Ph.D., John W. Robson, Ph.D., Jay E. Treat, Ph.D.

Assistant Professors Ulrich H. Bents, Ph.D., Robert M. Kalbach, Ph.D.

The Department of Physics offers the Master of Science and the Doctor of Philosophy degrees.

Prerequisites for admission to full graduate standing are 35 semester hours of undergraduate work in physics, completed with acceptable scholarship and providing adequately for advanced study in this field. This will normally include at least the following work beyond the level of general physics: two semesters in mechanics and in electricity and magnetism, and one each in optics, thermodynamics, modern physics, and laboratory work.

The beginning student's program for the M.S. degree is planned in consultation with an adviser assigned by the department. When the student chooses a special field of interest and a sponsor for his thesis, the latter becomes his adviser. Thirty units, including thesis credit, are required; and at least 15 must be in physics, including 311a, 315a, 330a and 330b.

Students of exceptional ability, as demonstrated in course work, a preliminary examination, and in independent work, may be invited to work for the Ph.D. degree. This degree requires mastery of the materials in at least 36 units of physics including 311a, 311b, 315a, 315b, 329, 330a, 330b, and 370a. A reading knowledge of two languages (to be chosen from German, Russian, or French) should be attained early in the graduate work (if not before). After completion of an independent piece of research, the student must present a dissertation which meets high standards of professional quality and represents a genuine contribution to physics. The dissertation must be defended in a final examination, and the student is expected to prepare a research article suitable for publication in a professional journal.

Research opportunities are currently available in spectroscopy, cosmic rays, nuclear emulsions, atmospheric physics, some aspects of biophysics, and in theoretical physics. Prospective students who wish to do research in some specific field should write the department in advance.

See page 38 for Master of Education degree major or minor in this department.

210. Theoretical Mechanics I (3) I, II
   Blitzer-Evett
   Dynamics of particles and of aggregates, emphasizing the use of vector methods. P, 15 and 20, and Mathematics 79b.
212. Theoretical Mechanics II (3) I
Blitzer-Evett

215a-215b. Electricity and Magnetism (3-3) Yr.
Kalbach

220. Geometric and Physical Optics (3) I
Robson
The principles of optics and their applications to optical systems. P, 15, 20, and Mathematics 79b.

225. Thermodynamics (3) II
Bents

232a-232b. Modern Physics (2-2) Yr.
Treat
Introductory course in modern physics; emphasis on current developments in atomic physics. P, 2b or 15 and 20.

240. Spectroscopy (2) I
Blitzer
The theory of spectra; applications to physics, chemistry, astronomy, and metallurgy. P, 2b or 15 and 20, Mathematics 79b.

270a-270b. Methods of Mathematical Physics (3-3) Yr.
Evett

290a-290b. Advanced Undergraduate Laboratory Physics I (1) Yr.
Staff
An introduction to laboratory techniques of importance in physics. Experiments designed to develop experimental skills and to demonstrate important ideas in physics. 3L. P, completion of or CR in two upper-division courses in physics.

291a-291b. Undergraduate Physics II (1) Yr.
Staff
Continuation of Physics 290a and 290b with emphasis on individual work. P, 209b, and completion of at least ten units of upper-division physics.

311a-311b. Advanced Mechanics (3-3) Yr.
Blitzer
The laws of motion as developed by Newton, Hamilton, Lagrange, and d'Alembert; dynamics of particles and rigid bodies. P, 270b or equivalent.

315a-315b. Electromagnetic Theory (3-3) Yr.
Kalbach
Theory of classical electromagnetic phenomena, including time-dependent and static solutions of Maxwell's equations, radiation theory, and relativistic electrodynamics. P, 270b or equivalent.

320. Theoretical Optics (3) I 1959-60
Robson

325. Thermodynamics and Kinetic Theory (3) II 1960-61
Evett
First and second laws of thermodynamics and their applications; Boltzmann transport equation, H-theorem; mean free path methods applied to viscosity, thermal conductivity, and diffusion. P, 225 or equivalent.

329. Statistical Mechanics (3) II 1959-60
Robson

330a-330b. Properties of Matter (3-3) Yr.
Weaver
Atomic, nuclear, and molecular theory; the states of matter. Sufficient quantum mechanics is introduced so that the topics covered can be discussed from this point of view. The course is intended to provide a minimum basic background for graduate work in physics. P, 130a, 150b or 252a, 252b; and 270b.

330a-330b. Nuclear Physics (3-3) Yr. 1959-60
Weaver
PLANT BREEDING

   Bents
   Constitution and properties of crystalline and amorphous state based on molecular,
   atomic, and electronic theory. Volume and surface characteristics, e.g. specific heat,
   deformations and stresses, conduction, magnetic and thermionic effects, photoelectric
   effects, and semiconductors. P, 330b.

370a-370b. Quantum Mechanics (3-3) Yr. 1960-61
   Staff
   Introduction to the principles of quantum mechanics; wave mechanics, and matrix
   mechanics; applications to atomic structure and spectroscopy. P, 270b, 330a.

377a-377b. Theory of Relativity (2-2) Yr. 1959-60
   Evett
   Special theory of relativity and its applications to mechanics and electrodynamics.
   Introduction to tensor calculus and general relativity. P, 270b.

383. Cosmic Rays (3) II 1960-61
   Treat
   Origin of cosmic rays; high energy electromagnetic and nuclear interactions; experi-
   mental techniques; characteristics of cosmic radiation. P, 330b.

384. High-Energy Particle Physics (3) I 1960-61
   Kalbach
   Production, interaction, and decay of mesons and hyperons; high-energy scattering
   of elementary particles; theoretical interpretation of new particles; experimental

385. Electron Optical Methods of Analysis (3) I 1959-60
   Wyckoff
   A discussion of the following techniques and their principle fields of application:
   fluorescent X-ray analysis (X-ray spectroscopy), micro-fluorescent X-ray analysis (elec-
   tron probe analysis), X-ray absorption analysis, projection and contact X-ray micro-
   scopy, electron diffraction for crystal identification. P, Physics 270b.

399. Seminar (1 to 3) I, II
   Staff
   Reports on current research and assigned topics. Special seminars will be held from
   time to time in: quantum electrodynamics, special topics in advanced classical mechanics,
   X-rays and crystal structure, electron microscopy, electron optical methods of micro-
   analysis, the morphology of the solid state, methods for the determination of crystal
   structure, and other subjects of current interest. Open only to qualified students.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (1 to 4) I, II

410. Thesis (2 to 4) I, II  Maximum total credit permitted, 8 units.

420. Dissertation (2 to 9) I, II

PLANT BREEDING

Professors Elias H. Pressley, D.Sc., Head, Lee S. Stith, Ph.D.

Assistant Plant Breeder (Arizona Agricultural Experiment Station) Arden A. Baltensperger, Ph.D.

The Department of Plant Breeding offers graduate programs leading to the
Master of Science and Doctor of Philosophy degrees. The Doctor of Philosophy de-
gree is offered with plant breeding as a field of specialization under the Plant
Science Program (see page 44).

The graduate student in plant breeding will complete the course work offered
by this department, pursue a research program in plant breeding, and possibly un-
dertake further intensive study on appropriate topics through special problems.
After conferring with his adviser, he will also elect certain courses from the fields
of botany, general agriculture (statistics), agronomy, and plant pathology.

225. Techniques of Plant Breeding (3) I
   Baltensperger
   An introduction to field, laboratory, and greenhouse methods and techniques used in
228. Plant Breeding (3) II

Critical examination of the various theories of heredity and their application to plant breeding. P, Botany 103, 132.

399. Seminar (1) II

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

399. Special Problems (1 to 5) I, II

400. Research (2 to 4) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

PLANT PATHOLOGY

Professors Rubert B. Streets, Ph.D., Head, Paul D. Keener, Ph.D.

Assistant Professor Alice M. Boyle, Ph.D.

The department offers to qualified students work leading to the Master of Science and Doctor of Philosophy degrees with specialization in diseases of fruits, vegetable crops, field and forage crops, or ornamentals; forest pathology and mycology. The Doctor of Philosophy degree is offered with plant pathology as a field of specialization under the Plant Science Program (see page 44).

Applicants for admission may offer an undergraduate major in plant pathology, botany, horticulture, agronomy, or plant breeding. Qualifying examinations may be required to determine preparation and aptitude of the candidate. Any deficiencies revealed must be removed by taking appropriate courses.

For the master's degree, at least 15 units must be taken in plant pathology. The remaining units may be chosen from Botany 202, 204, 242, 303; Entomology 205, 205, 299; Agricultural Chemistry 207, 221; Plant Breeding 228; General Agriculture 230, 237a-237b. A reading knowledge of German or French is recommended.

245. Diseases of Cereal, Fiber, and Forage Crops (4) I Streets-Staff

Bacterial, fungus, and virus diseases of cereal, fiber, oil, and forage crops. Special emphasis upon diseases of the Southwest. 2R, 6L. One 2-day field trip. Fee, $7.

250. Pathology in Forest Practice (4) I Keener

Designed for majors in forestry, range management, and watershed management with special emphasis on the pathogens of forest trees, principles, and methods of control. 3R, 3L. One-day field trip. Botany 1, 93 or 203. Fee, $7.

255. Diseases of Fruits, Nuts, and Small Fruits (4) II Streets-Staff

Bacterial, fungus, and virus diseases of deciduous, citrus, and subtropical fruits, pecans, walnuts, and small fruits. 2R, 6L. One 2-day field trip. Fee, $7.

260. Diseases of Vegetable Crops (4) II Boyle-Staff

Field, storage, and transit diseases of vegetable crops; cause, prevention, and control. 2R, 6L. One 2-day field trip. Fee, $7.

265. Diseases of Shade Trees and Ornamentals (4) II 1959-60 Streets

A study of the causes of annual losses due to diseases of shade trees, windbreaks, shrubs, vines, and flowers, and their control. 2R, 6L. Fee, $5.

270. Diseases of Citrus (4) I 1959-60 Streets

Cause and control of maladies affecting citrus orchards and fruit in storage and transit. 2R, 6L. P, Horticulture 208. One 2-day field trip. Fee, $7.

275. Methods in Plant Pathology (4) I 1960-61 Staff

Methods of direct examination and culturing of diseased plant materials and inoculation with and identification of pathogens. Laboratory, greenhouse, and field plot techniques. Preparation of specimens and illustrations. 2R, 6L. P, 11 units of plant pathology. Fee, $7.
POULTRY SCIENCE

285. Identification of Economic Fungi (3) I 1959-60 Streets
Training in the identification of fungi, with emphasis upon plant-parasitic forms of economic importance. 1R, 6L. Fee, $4.

320. Virus Diseases of Plants (4) II 1959-60 Keener
The nature of plant-disease viruses, symptoms they cause, their identification, and manner of transmission. 2R, 6L. P, 11 units of plant pathology; Botany 202, 203; Entomology 1; Plant Breeding 228. One 2-day field trip. Fee, $7.

325. Pathological History and Cytology (4) II 1960-61 Keener
Techniques in selecting and preparing diseased plant tissues for study; use of differential stains. 2R, 6L. P, 11 units of plant pathology; Botany 202, 242. Fee, $10.

399. Seminar (1 to 2) I, II Staff
Reports and discussions based upon recent contributions and discoveries in the field of plant pathology.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

POLITICAL SCIENCE

(See Government)

POULTRY SCIENCE

Professor _____________Head
Associate Professor Hubert B. Hinds, M.S.
Assistant Professor Allen A. Kurnick, Ph.D.

The Department of Poultry Science offers graduate work leading to the Master of Science degree with specialization in all phases of poultry science. In addition the department cooperates with the Committee on Biochemistry and Nutrition with both course work and research leading to the Doctor of Philosophy degree. Excellent farm and laboratory facilities are available for all phases of study and research with poultry. Students holding a Bachelor of Science degree from the University of Arizona or from institutions of equivalent standing are eligible for graduate study in the department.

202. Poultry Breeding (3) I 1960-61 Staff
Practical application of the principles of genetics to methods of poultry breeding. Emphasis is placed on systems of breeding and methods of selection. P, Botany 132.

(Identical with Animal Science and Dairy Science 210)

301. Advanced Animal Nutrition (3) II 1959-60 Kurnick

312. Chemistry of Enzymes (2) II 1960-61 Kurnick
Biochemical and physical principles as applied to the study of properties, functions, mode of action, isolation, purification, and identification of enzyme compounds. P, Chemistry 141b, 261a,b; or Zoology 253b, or Botany 303.

399. Seminar (1) I, II Staff
Offered jointly with the Departments of Animal Pathology, Animal Science and Dairy Science.
INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units

PSYCHOLOGY
(See Philosophy and Psychology)

PUBLIC ADMINISTRATION

COMMITTEE (GRADUATE)

Professors Shaw Livermore, Ph.D., Chairman, Russell M. Howard, M.S. (Accounting Philip G. Hudson, Ph.D. (Economics), Paul Kelso, Ph.D. (Government), Robert C. Stone, Ph.D. (Bureau of Business and Public Research).

Assistant Professor William J. MacKinnon, Ph.D. (Psychology).

Graduate work leading to the degree of Master of Public Administration is offered, with major fields of specialization in governmental administration, criminology and correctional administration, and probation-parole administration. Public administration on the graduate level is an interdepartmental responsibility. Representatives of the Departments of Government, Sociology, Economics, Psychology, and Business Administration, and of the Bureau of Business and Public Research comprise the Graduate Committee on Public Administration.

Courses of study undertaken by candidates for the master's degree will be prescribed individually by an appropriate adviser. The prerequisite is a bachelor's degree from an approved institution, preferably with undergraduate concentration in government and history, sociology, or public administration. Candidates lacking such background may be admitted by permission, but they will find additional time and course work necessary to fulfill prerequisites before being advanced to candidacy for the degree.

Undergraduate students in the University may prepare for careers in public administration or for graduate work in either the College of Business and Public Administration or the College of Liberal Arts. In the latter case, they will normally choose as major and minor fields in the upper division from among the fields of economics, government, history, psychology, and sociology.

The following courses include those which will normally be included in various programs of study for the degree of Master of Public Administration. Prerequisites may be satisfied by previous undergraduate course work or by inclusion in the first-year programs of students admitted to the graduate program prior to their advancement to candidacy.

In addition to these courses in Public Administration listed below, certain courses in other departments may be recommended for inclusion in graduate programs either before or after admission to candidacy. These courses include: Accounting 253, Economics 372, Government 266, 274, 370, Psychology 210, 253, 306, Sociology 212, 261, 301. Government 261a-261b (or its equivalent) will ordinarily be required of all candidates.

243. Welfare Legislation (3) II Yoshino
A survey and analysis of the provisions and administration of the major federal legislation in the area of social welfare.

245. Counseling in Social Administration (3) II Mulligan
The basic concepts and principles of counseling, casework, and interviewing in professional and administrative settings. P, Soc. 1 and 3 additional units of sociology.

263. The Administrative Process (3) II Burke
(Identical with Government 263)
265. Federal Police Systems (3) I  

266. Police Organization and Administration (3) II  
A thorough analysis of theory and practice of police organization and administration at the national, state, and local levels. P, Soc. 2 and 87.

267. Public Personnel Administration (3) I  
Kelso  

279. Urban Planning and Development (3) II  
Wilson  
(Identical with B.A. 279)

301. Human Relations in Administration (2) II  
Leonard  
(Identical with Soc. 301)

337a-337b. Fiscal and Budgetary Administration of Public Agencies (2-2) Yr.  
Martin  
Analysis of the internal fiscal operation, and the budgetary cycle, of public and non-profit agencies. Individual reports will be assigned. P, Acctg. 241.

345. Problems in Taxation (3) II 1960-61  
Hudson  
(Identical with Econ. 345)

346a-346b. The Dynamics of Probation and Parole (2-2) Yr.  
Mulligan  
A critical discussion of the techniques of social investigation, diagnosis, supervision, and treatment of the offender. P, 245 or equivalent.

366. Rehabilitative Services in Correctional Institutions (2) I  
Staff  

INDIVIDUAL STUDIES

405p. Internship in Probation and Parole (2-6) I, II  
Mulligan  
Student serves an internship of from 8 to 10 weeks on a full-time basis in a community correctional agency under professional and university supervision. Open only to graduate students in the probation and parole program. P, 346a-346b.

405c. Internship in Correctional Administration (2-6) I, II  
Staff  
The advanced student and candidate for the master's degree in the correctional program is required to spend time working in a penal institution under the guidance and supervision of responsible officials. Emphasis is placed on the practical aspects of the correctional field. Open only to graduate students in public administration. P, Soc. 87, 166a-166b, 287.

410. Thesis (4) Maximum total credit permitted, 4 units.

RANGE MANAGEMENT

(See Watershed Management)

ROMANCE LANGUAGES

Professors Renato Rosaldo, Ph.D., Head, Arthur H. Beattie, Ph.D., John Brooks, Ph.D.

Associate Professor Loyal Gryting, Ph.D.

Assistant Professors Timothy Brown, Jr., Ph.D., Dwight O. Chambers, Ph.D., Jack E. Davis, Ph.D., Robert M. Hammond, Ph.D., John J. Reynolds, Ph.D.

Instructor Charles Rosenberg, Ph.D.
FRENCH

For admission to graduate work the student must satisfy the Department of Romance Languages as to his ability to do work at the graduate level. For students studying for the degree of Master of Arts there are opportunities in French literature and French civilization. Supporting work may be taken in a closely related field or in education. The candidate must have completed a minimum of 24 semester hours of French at the undergraduate level exclusive of the elementary course.

Students will be encouraged to register for the independent study at the graduate level with members of the faculty in whose special field they are interested. To qualify for the degree of Master of Arts, the candidate must submit a thesis and pass both a written and oral examination covering all undergraduate work.

See page 38 for the Master of Education degree major or minor in this department.

201a-201b. Survey of French Literature (3-3) Yr. Gryting
A comprehensive view of the development of French literature from its medieval origins to modern times. An introduction to such movements or schools as the Renaissance, classicism, rationalism, romanticism, realism, naturalism, and symbolism. Conducted in French. P, 3b. 201a is not prerequisite to 201b.

202a-202b. French Civilization (2-2) Yr. 1960-61 Hammond
Historical, social, economic, literary, and artistic elements in the development of the French nation. Conducted in French. P, 3b. 202a is not prerequisite to 202b.

220. Literature of the Renaissance (2) II 1959-60 Gryting
Humanism; the new trends in prose and poetry; Marot, Rabelais, Marguerite de Navarre, Ronsard, Du Bellay, Calvin, Montaigne. Conducted in French. P, 3b.

230a-230b. Literature of the Seventeenth Century (2-2) Yr. 1960-61 Staff
Major emphasis in the first semester will be given to the tragedies of Corneille and Racine; in the second semester the works of Moliere and the non-dramatic literature of the century will be studied. Conducted in French. P, 3b. 230a is not prerequisite to 230b.

240a-240b. Literature of the Eighteenth Century (2-2) Yr. 1959-60 Hammond
240a will present the rational currents of the eighteenth century; 240b, feeling and sensibility in the eighteenth century. Conducted in French. P, 3b. 240a is not prerequisite to 240b.

251. Nineteenth-Century French Novel (2) I 1959-60 Beattie

252. Nineteenth-Century French Poetry (2) I 1960-61 Beattie

253. Nineteenth-Century French Drama (2) II 1960-61 Beattie
Romantic, realistic, naturalistic, social and poetic drama. Conducted in French. P, 3b.

260a-260b. Literature of the Twentieth Century (2-2) Yr. 1959-60 Rosenberg
The novel will be presented in 260a; poetry and drama in 260b. Conducted in French. P, 3b. 260a is not prerequisite to 260b.

No knowledge of the French language is required for the following course.

280a-280b. French Literature Translation (2-2) Yr. 1959-60 Beattie
Representative masterpieces of French literature. In the second semester major emphasis will be given to literary movements of the past half century. P, Humanities 50a-50b. 280a is not prerequisite to 280b.

399. Seminar (3) I, II
The topics for the seminar will be chosen from the following:

a. Old French or 16th Century.................................................................Gryting
b. 17th Century ..........................................................................................Staff
c. 18th Century ............................................................................................Hammond
d. 19th or 20th Century..............................................................................Beattie
SPANISH

The department offers courses which will lead to the Master of Arts degree in Spanish. The prerequisite for admission is a minimum of 16 acceptable units in upper-division Spanish or the equivalent. Candidates will consult with the head of the department about the courses which are to be taken. A minimum of 30 units is required for the degree, including 6 to 8 units for the thesis. It is possible to minor in some other subject with the permission of the head of the department. A written examination covering the field will be given, in addition to the oral examination.

See page 38 for the Master of Education degree major or minor in this department.

Spanish 104a-104b is prerequisite to all courses listed below.

201a-201b. Spanish-American Literature (3-3) Yr. 1960-61 Rosaldo
Conducted in Spanish. 201a is not prerequisite to 201b.

202a-202b. Hispanic-American Civilizations (3-3) Yr. Staff
Conducted in Spanish. 202a is not prerequisite to 202b.

206a-206b. Modern Spanish-American Prose (2-2) Yr. 1959-60 Rosaldo
The novel will be studied in 206a; the short story (cuento) and essay in 206b.
Conducted in Spanish. 206a is not prerequisite to 206b.

210a-210b. Survey of Medieval Spanish Literature (2-2) Yr. 1959-60 Staff
Conducted in Spanish. 210a is not prerequisite to 210b.

230a-230b. Literature of the Golden Age (3-3) Yr. Brooks
Conducted in Spanish. 230a is not prerequisite to 230b.

251a-251b. Spanish Literature of the Nineteenth Century (3-3) Yr. 1959-60 Staff
Conducted in Spanish. 251a is not prerequisite to 251b.

260a-260b. Spanish Literature of the Twentieth Century (3-3) Yr. Reynolds
Conducted in Spanish. 260a is not prerequisite to 260b.

270. Advanced Grammar (2) Yr. 1960-61 Reynolds

298. Seminar on Latin America (2-2) Yr. Rosaldo-Staff
P, 3 years of college Spanish or graduate standing. Required of all majors in Latin American studies.

399. Seminar (2) I, II
The topics for the seminar will be chosen from the following:

a. History of the Spanish Language .........................................................Brooks
b. Old Spanish ...........................................................................................Brooks
c. Spanish Renaissance Literature .............................................................Chambers
d. La Comedia del Siglo de Oro .................................................................Reynolds
e. La Novela Española del Siglo XIX .........................................................Staff
f. Brazilian Literature ................................................................................Brown
g. Literatura Colonial de Hispanoamérica .................................................Rosaldo
h. El Modernismo .....................................................................................Davis
i. El Teatro en Hispanoamérica .................................................................Rosaldo
j. La Novela de la Revolucion Mexicana ..................................................Rosaldo
400. Research (2 to 4)

410. Thesis (2 to 8) I, II A minimum of 4 units of thesis and a maximum of 8 units.

SECRETARIAL STUDIES AND BUSINESS ADMINISTRATION

Professor Herbert J. Langen, Ph.D., Head
Assistant Professors Richard A. Kidwell, Ed.D., Florence W. Toland, M.S.

No advanced degree in secretarial studies is offered. The courses listed below may be approved for inclusion in graduate study programs of students in other departments.

See page 38 for the Master of Education degree major or minor in this department.

272. Office Management and Control (3) I Langen Office management from the supervisory point of view. Analysis of functions of various office departments, their organization and management. Development and use of office manuals; selection, training, pay and promotion of office employees; controlling office expenses and measuring office efficiency; quality and quantity production standards. P, 9 hours of secretarial studies or business administration courses.

273. Advanced Techniques for Office Control (2) II Langen The analysis and application of modern techniques for special office situations in various businesses. P, 77 or equivalent office experience. Fee, $3.

280. Executive Secretarial Training (3) I Toland Advanced dictation and transcription and emphasis on secretarial duties in preparation for advancement to positions of executive responsibilities. P, 174b or ability to take dictation at 100 words per minute for five minutes. Fee, $5.

INDEPENDENT STUDIES

299. Special Problems (1 to 5) I, II

SOCIOLOGY

Professors ———————— Head, Frederick A. Conrad, Ph.D., Donald S. Klaiss, Ph.D., Raymond A. Mulligan, Ph.D., Robert C. Stone, Ph.D.

Associate Professors William C. Lawton, Ph.D., Harry T. Getty, Ph.D. (Anthropology), Bernard C. Hennessy, Ph.D. (Government)

Assistant Professors I. Roger Yoshino, Ph.D., William J. MacKinnon, Ph.D. (Psychology)

Instructor Joseph R. Hambenne, M.A.

Lecturers Bernard L. Garmire, Robert A. Hackenberg, M.A. (Anthropology)

The Department of Sociology offers graduate work leading to the Master of Arts degree. The prerequisite for admission is graduation from an approved college or university with a major in sociology or a concentration in sociology and closely related subjects. A minimum of 20 units in sociology and 10 units in psychology or anthropology may be offered in lieu of an undergraduate major in sociology.

Course requirements for a graduate major in sociology follow the usual plan for the degree. Certain courses in advanced theory and a course in statistics may be required if the student's background is deficient in these subjects or if they are deemed essential to the program of study.

A limited number of pre-professional courses in social work may be included in the major, but the department does not offer graduate work leading to a professional degree in social work.
Graduate work leading to the Master of Public Administration degree is also offered, with major specialization in governmental administration, criminology and correctional administration, and probation-parole administration (see page ...).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>210</td>
<td>The Individual in the Group (3) I, II</td>
<td>MacKinnon</td>
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<td>(Identical with Psychology 210)</td>
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<td>212</td>
<td>Sociology of Collective Behavior (3) I</td>
<td>Yoshino</td>
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<td></td>
<td>An analytical approach to the principles common to such aspects of collective behavior as the crowd, the public, and such social movements as those having a political, religious, or minority context. P, 1 or 2 and Psych. 1a or 1b.</td>
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<tr>
<td>222</td>
<td>Sociology of Minority Relations (3) II</td>
<td>Yoshino</td>
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<td>A critical approach to the social processes involved in minority relations in terms of race, caste, class, ethnicity, politics, and religion. The sources of minority attitudes; patterns of minority adjustments; trends in minority relations. P, 1 and 2, or 6 units of anthropology. (Identical with Anthro. 222)</td>
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<tr>
<td>235</td>
<td>Public Opinion (3) II</td>
<td>Hennessy</td>
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<td>(Identical with Govt. 235)</td>
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<td>240</td>
<td>Child Welfare Problems (2) I</td>
<td>Mulligan</td>
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<td></td>
<td>Extent, causes, and treatment of child welfare problems in the field of social work; child welfare agencies and services. P, 1 and either 138 or 6 additional units of sociology or psychology.</td>
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<td>241</td>
<td>Juvenile Delinquency (3) II</td>
<td>Mulligan</td>
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<td>Extent, causes, and control of juvenile delinquency. P, 1.</td>
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<td>245</td>
<td>Counseling in Social Administration (3) II</td>
<td>Mulligan</td>
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<td>(Identical with Pub. Adm. 245)</td>
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<tr>
<td>252</td>
<td>Social Stratification (3) II</td>
<td>Mulligan</td>
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<td></td>
<td>Theories and character of status systems. Theories of and research in social structure, social differentiation, relations between social stratification and social institutions. Some emphasis on sociometric methods. P, 1 and 3 additional units of sociology, or 6 units of anthropology. (Identical with Anthro. 252)</td>
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<tr>
<td>253</td>
<td>Group Dynamics (3) II</td>
<td>Mulligan</td>
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<td></td>
<td>Analysis of factors and processes of social groups. Deals with such problems as group leadership, group effectiveness, group goals, communication within groups, and their individual members. P, 1 and 3 additional units of sociology or Psych. 1a, 1b. (Identical with Psych. 253)</td>
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<tr>
<td>257</td>
<td>Child-Rearing Practices and Their Cultural Determinants (3) II</td>
<td>Christopherson</td>
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<td>(Identical with Home Economics 257)</td>
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<tr>
<td>260a-260b</td>
<td>Methods of Social Research (2-2) Yr.</td>
<td>Lawton</td>
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<td></td>
<td>Techniques for measurement and interpretation of social behavior; surveys, case studies, questionnaires, interviewing, statistical, and experimental studies. Application of principles in a community study may be required. P, 1 and 6 additional units of sociology or anthropology. (Identical with Anthro. 260a-260b.)</td>
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<tr>
<td>261</td>
<td>Introductory Social Studies (3) I, II</td>
<td>Staff</td>
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<td></td>
<td>Methods of processing and presenting social data, with emphasis on tabular and graphic presentation, elementary statistical inference, and distribution-free measures. P, 1.</td>
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<td>277</td>
<td>Modern Communities (3) II</td>
<td>Getty</td>
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<td>(Identical with Anthropology 277)</td>
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<tr>
<td>279</td>
<td>Culture and the Individual (3) II</td>
<td>Hackenberg</td>
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<td>(Identical with Anthropology 279)</td>
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<td>280</td>
<td>Introductory Sociological Theory (3) I</td>
<td>Hambenene</td>
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<td></td>
<td>A critical review of the leading sociologists from Auguste Comte to the present day. P, 1.</td>
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281. Principles of Sociology (3) II  
Conrad  
Analysis of the nature and structure of society; types of groups and associations; their functions, organizations, and control; examination of theories of human nature and the social order. P, 1 and 2.

282. Social Organization (3) I  
Hambenne  
Theories and problems of social organization and social control. Analysis of social change and disorganization as they relate to individuals, groups, and communities. P, 1 and 2.

283a-283b. Social Evolution and Progress (2-2) Yr.  
Lawton  
Analysis of factors and processes of social change; theories of social evolution and progress. P, 1.

284. Regional Sociology of the Southwest (3) I  
Klaiss  
Sociological analysis of populations, cultures, and social institutions in their regional setting. A review of major regions in the United States with special emphasis on the Southwest. P, 1 and 3 additional units of sociology, or 6 units of anthropology.

285. Sociology of the Family (3) II  
Klaiss  
Analysis of the modern family and its institutions in their social and historic setting. P, 1 and 3 additional units of sociology.

286. Sociology of Industry (3) I  
Ireland  
Analysis of social roles and relationships within the occupational structure; formal and informal groups and organizations in industry; the relation of industrial organization to other aspects of the community and the larger society. P, 1 and 2, or 6 units of economics.

287. Criminal Psychopathology (2) I  
Staff  
This course concerns itself with specific mental and emotional disorders of criminal behavior from the point of view of causation and development of abnormal behavior. Consideration of various approaches of diagnosis and treatment in psychiatric settings. P, 2, 87, and Psych. 1b.

288. Penology (3) II  
Staff  

289. Population Problems (3) I  
Klaiss  
Analysis of population; its composition, distribution, growth, migration; emphasis on population of the United States. P, 1 and 2 or Economics 1b or 2b.

290. Problems of Aging (3) II  
Klaiss  
Analysis of the aging-population structure and the social problems of aging and retirement in American society. P, 1 and 3 additional units of sociology.

291. Rural and Urban Communities (3) II  
Conrad  
Trends in rural-urban populations; comparisons of rural and urban modes and standards of living; analysis of typical institutions and their problems growing out of changes in rural-urban relations and community organization. P, 1 and either 3 additional units of sociology or Econ. 1b.

292. Social Investigation (2) I, II  
Staff  
Methods of locating, classifying, and evaluating data, and writing a report on the findings. P, 260b, 261, or equivalent.

293. Social Ecology (3) I  
Conrad  
Factors influencing the spatial distribution of populations and institutions; processes such as concentration, dispersal, succession, and dominance as they affect the ecological organization of cities, metropolitan areas, and regions. P, 1 and 3 additional units of sociology.

301. Human Relations in Administration (2) II  
Leonard  
A seminar dealing primarily with a discussion of case problems in the areas of industrial and governmental management and administration. P, 286 or B.A. 202. (Identical with B.A. 301)

315. History of Social Thought (3) I  
Conrad  
Analysis of social theories from the Greeks to the close of the 19th century with emphasis on the relation of social thought to the social forces of the time. Special emphasis on the development of concepts and views which paved the way for contemporary sociology.

316. Contemporary Sociological Theories (3) II  
Hambenne  
A review of the development of sociological theories and of the sociological movement since 1900.
341. The Theory of Juvenile Delinquency (2) I
Mulligan
Analysis of the sociological and psychological variable in the etiology of juvenile delinquency in American society. Some emphasis on a socio-psychological explanation of juvenile delinquency and the application of theory to rehabilitation and prevention. P, 241 and Psych. 1b.

387. Theory of Criminology (2) I
Staff
Historical and theoretical aspects of academic criminology. Contributions of the great individual thinkers with special emphasis on the recognized schools of criminological theory. P, 87.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 4) I, II
410. Thesis (4) I, II Maximum total credit permitted, 4 units.

SPANISH
(See Romance Languages)

SPEECH

Professors Klonda Lynn, Ph.D., Head, Alethea S. Mattingly, Ph.D.
Associate Professors James D. Lambert, Ph.D., George F. Sparks, Ph.D., Robert C. Burroughs, M.S. (Drama)
Assistant Professor J. W. Patterson, Ph.D.
Instructor Kenneth Dimmick, M.A.
Lecturer Ben Markland, Ph.D.

Graduate work in speech leading to the Master of Arts degree is designed to qualify students for teaching the various branches of speech (speech correction, interpretation, forensics, for example) or to qualify them for certification as speech clinicians or audiologists. Ample opportunities are available for research in applied phases of speech work. The Speech Laboratory is equipped with standard apparatus for recording and analyzing speech and hearing for making physiological and psychological tests. The Speech Clinic is equipped with consultation and practice rooms. A program of close cooperation between the University Speech and Hearing Clinic and other rehabilitation centers in Tucson presents an unusual opportunity for experience with the more severe disorders of speech and hearing. A broad program of intramural and intercollegiate debating and public speaking provides opportunity to observe and assist in the direction of these corollary parts of the educational speech program, while a large group of students in beginning classes in public speaking provides ample material for many types of statistical analysis bearing upon problems of speech education. Also available are the well-equipped radio, educational television (KUAT) and film studios located in Herring Hall.

Persons seeking admission to graduate work in speech must present the bachelor's degree with a major in speech or an area of concentration in speech and English, psychology, or education representing a minimum of 24 units, 15 of which must be in speech.

A limited number of teaching assistantships are available which, in addition to a salary, carry remission of tuition and permit full-time graduate study.

The ability to speak clearly and effectively before groups is expected of all candidates. Additional undergraduate courses may be required of any candidate found deficient in this ability.

See page 38 for the Master of Education degree major or minor in this department.
206a-206b. Radio and Television Writing (3-3) Yr. Markland
(Identical with Journalism 206a-206b)

208. Radio-TV Production (3) I Barreca
Production and direction of various types of radio and television programs, including supervision of lighting, special effects, and casts. P, 206b or Journalism 206b.
(Identical with Journalism 208)

210. Problems in Speech Training (3) II Lynn
Study of objectives, materials, and techniques for developing speech skills. P, 15 units in speech.

213. Studies in Discussion (2) I Sparks
Investigation of source materials and research literature pertaining to public and group discussions. P, 113.

218. Persuasion (3) II Sparks
The principles of motivating human conduct; applying the principles in speeches.

220. Classical Rhetoric (3) I Sparks
A study of Greek and Roman rhetorical principles. The analysis of selected orations of these periods. P, 2, 10.

222. British Oratory (3) II 1960-61 Staff
History and criticism of British speakers from the eighteenth century to the present. P, 220.

224. American Oratory (3) II 1959-60 Sparks
History and criticism of American speakers from colonial times to the present. P, 220.

236. The Oral Interpretation of Shakespeare (3) I Mattingly
Character analysis and presentation of selected scenes from representative comedies, histories, and tragedies. P, 137a or 137b.

245. Advanced Oral Interpretation (3) II Mattingly
History and trends of platform reading; aesthetic criteria, analytical study of literary forms, emphasizing their differentiation for oral presentation; preparation and presentation for public recital. P, 5 or 267, 36 and 137a or 137b or CR.
(Identical with Drama 245)

260. Voice Science (3) I Lambert
Vocal anatomy; the physical characteristics of speech sounds; and the psycho-physical processes involved in hearing.

267. English Phonetics (3) I Lynn
A scientific study of the structure of English speech; laws and principles determining the facts of pronunciation.

269. Speech Correction (3) II Lynn
A survey of the field of speech correction and of the common defects of speech; methods of detection and general principle of retraining. Open to teachers.

270. Speech Pathology (3) I Lambert

272. Applied Phonetics (3) II 1959-60 Lynn

277. Clinical Techniques in Speech and Hearing Disorders (1 to 3) I, II Dimmick
May be repeated for a total of 8 units. P, 269 or CR.

278. Audiology (3) I Lambert
Description of normal audition; structure and functioning of the hearing mechanism; causes and types of hearing loss and their effects on the individual and his speech. P, 260.

279. Audiometry (3) II Dimmick
The principles and techniques of auditory testing, and the interpretation of hearing tests. P, 278.

281. Lip Reading (4) II Lambert-Dimmick
Presentation of basic principles for understanding language through the observation of the speaker’s lips, facial expression, and body activity. Emphasis on theory and development of skill in speech reading and in the teaching of speech reading. 3R, 3L, P, 267, 278, 279 or CR.
282a-282b. Language and Speech For The Deaf and Hard of Hearing (3-3) Yr. Dimmick
Stage by stage instruction for teaching language and speech to deaf and hard of
hearing children of all ages. Emphasis on basic problems confronting the acoustically
handicapped; specific methods and equipment used in instruction. 3R, 3L, P, 281.

300. Introduction to Graduate Study in Speech (2) I Staff
A survey and study of problems relating to graduate research, including bibliog-
raphies, methods of research, and experimental design. Required of all graduate majors
in speech.

337. Theories of Oral Interpretation (3) I Mattingly
A study of the mechanical and natural schools of oral interpretation, their back-
grounds, and their influence upon modern teaching and performance.

369. Advanced Study of Speech and Hearing Disorders (3) II Lambert
Critical study of experimental research dealing with the etiology and diagnosis of
speech and hearing disorders and related remedial procedures. P, 269.

371. Psychological Disorders of Speech (2) I Lambert
Psychogenic speech disorders, including stuttering and aphasia; symptoms, etiology,
diagnosis, and therapy. P, 269, 270, Psychology 1a-1b, 218.

372. Organic Disorders of Speech (3) II Lambert
Etiology, diagnosis, therapy, and prognosis of those speech disorders arising from
organic pathologies such as cerebral palsy, cleft palate, and laryngeal anomalies. P,
269, 270, or equivalent.

399. Seminar (2) I, II

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (1 to 3) I, II
410. Thesis (2 to 4) I, II Maximum total credit permitted, 4 units.

SYSTEMS ENGINEERING

Systems engineering refers to that particular class of technological systems in
which the measures of effectiveness are necessarily and directly involved with the
structure of human values. While nearly all engineering work is a consequence of
socio-cultural need, the measure of effectiveness may or may not be directly in-
volved with human value scales. Systems engineering emerges only when this
involvement is direct. Thus systems engineering involves all the tools of analysis
and design required in all fields of engineering in addition to organized study
in the structure of human values and its reduction to quantitative and systematic
criteria.

Students interested in this subject area should have a B.S. degree in engineer-
ing or science and a minimum of three to five years of appropriate experience.

No advanced degree is offered in systems engineering. The study program
is developed at the graduate level around a major in applied mathematics, civil
engineering, electrical engineering or mechanical engineering. Supporting work
in systems engineering should include appropriate selections from the following
list of courses:

ANTHROPOLOGY 203. Cultural Change (3) II 1959-60 Spicer
ANTHROPOLOGY 276. Comparative Social Changes (3) I Spicer
ECONOMICS 207. Comparative Economic Systems (3) II Schmidt
ELECTRICAL ENGINEERING 338. Methods of Communications Theory and Detection Theory (3) I, II Korn
ELECTRICAL ENGINEERING 340. Synthesis of Control Systems I (3) I Weaver
ELECTRICAL ENGINEERING 342. Sampled-Data and Digital Control Systems (3) II Weaver
WATERSHED MANAGEMENT

Professors Andrew L. McComb, Ph.D., Head, Robert R. Humphrey, Ph.D.
Associate Professor Philip N. Knorr, Ph.D.
Assistant Professors Robert F. Wagle, Ph.D., David G. Wilson, M.S.
Instructor Ervin M. Schmutz, M.S.

The Department of Watershed Management offers graduate work leading to the Master of Science and Doctor of Philosophy degrees in range management and the Master of Science degree in watershed management. The Ph.D. degree is offered with range management as a field of specialization under the Plant Science Program (see page 44).

The objective of the graduate program in watershed management is to train men with a land management background in a field requiring a broad outlook toward fundamental human, animal, plant, soil, and climatic relationships. To provide this background, the watershed manager needs training in a number of fields which entails the crossing of departmental boundaries to obtain courses in soils, engineering, meteorology, geology, and mathematics. The proposed curriculum will produce the highly trained men needed to evaluate and increase our watershed resources.

At least 12 units in forest or range subjects will constitute the basic requirements for graduate work in the department. These subjects shall be in fields which constitute, in the judgment of the department, a background in land management. If the required 12 units have not been completed for undergraduate credit, they must be included as a part of the graduate program prescribed by the department.

Research in range management may be conducted in any of the various phases of this field. These include range management practices, range condition analysis, noxious plant control, range revegetation, range fertilization, forage utilization, relation between big game animals and domestic livestock, poisonous plants, nutritive value of range plants, physiology and ecology of range plants, and hydrologic effects of range management practices. Research facilities include the Page-Trowbridge Experimental Ranch, the Santa Rita Research Center, and irrigated farmland and a greenhouse at the University Plant Materials Center. Cooperative studies with ranchers constitute an important part of the research program.

RANGE MANAGEMENT

202. Range Forage Plants (4) I
   Identification, forage values, and proper management of range plants—grasses, forbs, and shrubs; poisonous plant identification and control. 3R. 3L. P, Botany 1. Fee, $7.
205. Range Management (3) I
Management of ranges and range livestock, range administration, technical field problems, range surveys, management plans. 2R, 3L, P, 202 or Botany 2. Fee, $7.

216. Range Ecology (4) I
Ecological principles underlying sound domestic-livestock and big-game range management. The ecology of range forage plants, range weeds, poisonous plants, and forage production. 3R, 3L, P, 202. Fee, $7.

218s. Range Field Studies (3) Summer
A summer field trip designed to give students an opportunity to observe at first hand practical application of the principles of range management and ecology. Study of grazing problems on forest, brush, and grass ranges; noxious-plant control methods, revegetation techniques. Fee, $60 (transportation).

256. Range Resources (3) II
Grazing regions of the United States; their ecological relationships and value for grazing. P, 202, 216.

286. Range Forage Evaluation (3) II
Concepts and techniques of range-survey, forage-utilization, and range-condition analysis. 2R, 3L, P, 202, 205, 216 or equivalent. Fee, $7.

346. Range Research Methods (3) I
Analysis and field practice in various forage-measurement techniques, problem analysis, experimental design, and scientific writing. 2R, 3L, P, 202, 216. Fee, $7.

399. Seminar (1) II
Special problems relating to applied and technical range management; assigned reading and discussion.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II

400. Research (2 to 8) I, II

410. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units.

420. Dissertation (1 to 9) I, II

WATERSHED MANAGEMENT

205. Resource Protection (3) II 1960-61
Protection of watersheds from wildfire, insects, and disease. Fire detection and suppression systems. Protection economics. 3R, P, junior standing.

210. Silviculture (3) II 1960-61
The principles and technical procedures for reproducing, planting, and tending forest crops with reference to watershed. 2R, 3L, P, 155, 140. Fee, $5.

215. Mensuration (4) I 1959-60
Inventory in terms of land and forest growth, raw materials, and products in relation to watershed management. 2R, 6L, P, Civil Engineering 51, Mathematics 24. Fee, $8.

220. Photogrammetry (3) I 1959-60

225. Wood Technology and Utilization (4) II 1959-60
The anatomy, structure, and uses of commercially important woody plants and their identification, 2R, 6L, P, 135, 140. Fee, $7.

230. Forest Management (4) I 1960-61
The financial aspects of managing watershed properties on a long-time investment basis in interest and other costs. 2R, 6L, P, 135, 140, 210, 215. Fee, $6.

335. Forest Influences (3) 1960-61
Forest ecology and the influence of forest vegetation on soil-water relationships. 2R, 3L, P, Geology 1a, Soils 11, 140, 210. Fee, $7.

340. Watershed Hydrology (4) II
Water-budget studies for areas of various sizes and cover. Effect of climatic physiographic, pedologic, and geologic characteristics of catchment areas on water yields. Erosion of soil material and sediment movement and deposition. 3R, 3L, P, 335, Geology 1a. Fee, $8.

WATERSHED MANAGEMENT
399. Watershed Management Seminar (1) I
Special problems relating to applied and technical watershed management will be studied and discussed. 1st yr, senior standing.

INDIVIDUAL STUDIES

299. Special Problems (1 to 5) I, II
400. Research (2 to 8) I, II
410. Thesis (2 to 8) Maximum total credit permitted, 8 units.

WILDLIFE MANAGEMENT
(See Zoology)

ZOOLOGY

Professors Albert R. Mead, Ph.D., Head, William H. Brown, Ph.D.
Associate Professors E. Lendell Cockrum, Ph.D., Charles H. Lowe, Ph.D., William J. McCauley, Ph.D., Joe T. Marshall, Ph.D., John V. Slater, Ph.D.,
Assistant Professors Joseph T. Bagnara, Ph.D., Robert B. Chiasson, Ph.D., Wayne R. Ferris, Ph.D.
Instructor Donald B. Sayner

ARIZONA COOPERATIVE WILDLIFE RESEARCH UNIT

Associate Professor Lyle K. Sowls, Ph.D., Leader
Assistant Professor William J. McConnell, Ph.D., Assistant Leader
Instructor Charles R. Hungerford, M.S., Assistant Leader

The University is situated in the heart of the Sonoran Desert at an elevation of 2,400 feet. No other area offers a greater array of field problems in zoology than Arizona, where numerous isolated mountain ranges with desert to alpine habitats contain essentially unexplored, unique faunas. The proximity of northwestern Mexico and the Gulf or California provides almost unlimited research opportunity in field and laboratory zoology. Within a short range, marine, freshwater, and terrestrial environments are available for study. The availability of animal quarters and laboratory facilities, including electron microscopes and extensive isotope equipment, presents unusual opportunity for research in experimental zoology. The facilities of the Southwestern Research Station (American Museum of Natural History) in the Chiricahua Mountains are available upon permission to qualified students.

The zoological acquisitions in the University Library are the most extensive in the state and reflect years of careful procurement. In addition to American journals, many current foreign journals are received.

The collections of the Department of Zoology contain many thousands of specimens which are available to advanced students for study and research in invertebrate zoology, ichthyology, herpetology, ornithology, and mammalogy. These collections are continually expanding through research activities emphasizing the distinctive fauna of the Southwest.

Work leading toward the Master of Science and Doctor of Philosophy degrees is offered. Prior to admission to full graduate standing, the student must have completed the equivalent of a undergraduate major in zoology, viz., 32 units of zoology, including a year of general zoology and one semester each of comparative anatomy or embryology, physiology, and genetics or evolution (20 units
must be upper division); and a year each of organic chemistry and physics. Students anticipating advanced work in zoology are encouraged to include calculus and two foreign languages in their undergraduate programs. Applicants for admission are urged to submit both aptitude and advanced test scores of the Graduate Record Examination. Students admitted without the Graduate Record Examination must take it at the first opportunity during their first year in residence.

Requirements for the Doctor of Philosophy degree follow those set forth by the Graduate College. In addition, it is expected that candidates for this degree in zoology will complete a summer course in marine biology, or its equivalent, before the degree is conferred.

See page 38 for Master of Education degree major or minor in this department.

WILDLIFE MANAGEMENT. Through the cooperation of the University of Arizona, the Arizona Game and Fish Department, the United States Fish and Wildlife Service and the Wildlife Management Institute, a Cooperative Wildlife Research Unit is maintained at the University. The Unit offers graduate research assistantships in wildlife management and in fisheries management.

Students may pursue either the Master of Science or the Doctor of Philosophy degree through research on wildlife management problems. The Doctor of Philosophy degree may be approached through a major in zoology for students interested in problems of a zoological nature, or, for those concerned primarily with research studies of game range, the degree is offered with wildlife management as a field of specialization under the plant science program (see page 44).

For further information, the student is referred to the Leader, Arizona Cooperative Wildlife Research Unit.

210. Quantitative Zoology (3) I
   Procurement and analysis, evaluation, and publication of quantitative data obtained from living and preserved specimens; and development of quantitative problems. Primarily a laboratory course treating materials and advanced problems in zoology. 2R, 2L. Two field trips. P, 16 units of biological science; Mathematics 11 or 20, or equivalent algebra. Fee, $5.

211. History of Biology (2) II
   The great writings in botany, medicine, and zoology.

212. Biological Materials for Laboratory and Classroom Projects (2) II
   Sources, preparation, and presentation of biological material for study at the secondary-school level. Designed to be useful to teachers of biology in secondary schools. 1R, 3L. P, 1a or Bot. 1 and 8 additional units in biological science. Fee, $5.

216. Zoogeography (2) II
   Principles and concepts concerning the great regional patterns of distribution of the animals of the world, both past and present. P, 1b.

217. Techniques of Biological Literature and Nomenclature (2) II
   A critical study of the biologically important works of reference; development of techniques for finding and assembling complete information relative to any biological subject; selecting the scientific problem; preparation of the scientific report; examination of publication procedure; taxonomy and biological nomenclature. P, junior standing in a biological science.

218a-218b. Scientific Illustration (2 to 4-2 to 4) Yr.
   Basic training in the planning and execution of maps, graphs, and realistic drawing of specimens for thesis and publication in the areas of zoology, anthropology, botany, geology, etc. The problems peculiar to a particular interest will receive special attention. Techniques based on modern methods and materials. 2R, 6L. Units by arrangement. Fee, $5. (Identical with Anthropology 214a-214b, Botany 218a-218b, and Geology 218a-218b)

219. Scientific Photography in Zoology (2) I
220. Invertebrate Zoology (4) II
Comparative morphology, physiology, and biology of invertebrates with emphasis on phylogeny. 2R, 6L. One field trip. P, 1a. Fee, $10.

221. Photozoology (4) I
Systematics, life histories, morphology, physiology, growth, genetics, and reproduction in the Protozoa. 2R, 6L or field trips. P, 1b, Chem. 140b. Fee, $10.

229. Parasitology (4) I
The biology, distribution, symptomatology, pathology, epidemiology, diagnosis, treatment, and control of parasites of man and domestic animals, with emphasis on the evolution of parasitism and host-parasite relationships. 2R, 6L, P, 16 units in zoology or bacteriology. Fee, $10.

231. Limnology (4) I
The structural, physical, and chemical attributes of lakes and streams with reference to primary organic productivity and the dependent plant and animal community. 2R, 6L or field work. P, la or Botany 1 or 2 and 1 year of chemistry or physics. At least 2 weekend field trips. Fee, $10.

232. Ichthyology (4) II 1960-61
The systematics, ecology, and evolution of fishes. 2R, 6L or field work. P, 1b. Fee, $10.

233. Herpetology (4) II 1959-60
The systematics, ecology, and evolution of the amphibians and reptiles. 2R, 6L or field work. P, 1b. Fee, $10.

234. Ornithology (4) II
The natural history of birds and its bearing upon the problems of animal behavior, distribution, and evolution. 2R, 2L, 4-hour field trip. P, 1b. Fee, $10.

235. Mammalogy (4) I
The systematics, ecology, and evolution of mammals. 2R, 6L or field work. P, 1b. Fee, $10.

238. General Ecology (4) I
Interrelations of organisms and their environment; ecological concepts and principles; physical and biotic affecting the evolution, behavior, and patterns of distribution of organisms; analysis of plants, invertebrates, and vertebrates. 2R, 6L. P, lb, or la with junior standing in botany, entomology, or range management. Fee, $10.

242. General Cytology (4) I
The structure and function of cell organelles in division and during physiological activity. Laboratory experiments using selected microscopical techniques designed to illustrate the cell in various states of activity. 2R, 6L, P, 8 units of biological science and Chem. 140b. Fee, $10.

246. Animal Histology (4) I
Microscopic anatomy of animal tissues and the techniques involved in their preparation. 2R, 6L, P, 1b. Fee, $10.

248. Comparative Odontology (3) I 1959-60
The structure, development, and evolution of teeth. Primarily designed for majors in anthropology, paleontology, and zoology. 2R, 3L, P, 1b or Anthropology 140b or Geology 209. Fee, $10.

253a-253b. Mammalian Physiology (4-4) Yr.
McCueley
253a covers the physiology of the circulatory, respiratory, digestive, and excretory systems. 253b covers the physiology of the special senses and of the muscular, nervous, and endocrine systems. 3R, 3L, P, 40 or 41 or 143 and Chemistry 140b. Fee, $10.

253a-253bL. Mammalian Physiology (1-1) Yr.
McCueley
Laboratory experiments designed for students whose major field is in physiology. 3L, P, CR 253a-253b.

244. Comparative Physiology (4) II
Evolution of physiological mechanisms and the physiological basis of ecology. 2R, 6L, P, 1b, Chemistry 140b. Fee, $10.
255. General Endocrinology (3) I  
A general review of internal secretions and of the interrelationships of the endocrine glands of vertebrates and invertebrates. P, 1a, Chem. 140b.

256. Cellular Physiology (4) I  
Slater
Physiology at the cellular level. Includes consideration of the structure and function of cellular membranes and organelles. 2R, 6L. P, Chemistry 140b. Fee, $10.

257. Neurology (4) II  
McCauley
The structure and function of the mammalian central nervous system. 2R, 6L. P, 40 or 41 or 143. Fee, $10.

257R. Neurology (2) II  
McCauley
Supplemental recitations in neurology. Designed for students whose major field is in physiology or anatomy. 2R. P, CR 257.

260. Wildlife Management (4) I  
Hungerford
Management of wildlife as a resource. The study of the characteristics of game species and the principles of the production and control of game populations. 3R, 3L or field work. P, 60 and one field course in zoology, botany, or watershed management. Fee, $10.

261. Current Problems in Fishery Management (1) I, II  
McConnell
Reporting and discussion of literature relating to research and application of research to fishery management. P, 12 units in a biological science.

265. Wildlife Management Techniques (4) II  
Hungerford
Field and laboratory methods used in game management. Evaluation of game habitats. Census, productivity, diagnosis, and control of game populations. 2R, 6L or field work. P, 260. One weekend field trip. Fee, $10.

268. Fishery Management (4) II  
McConnell
Principles and methods pertaining to fishery investigation, management, and development. 2R, 6L. P, 16 hours in Zoology, and 3 hours in statistics or biometry. Fee, $10.

275. Evolution (2) II  
Brown
History, theories, and mechanics of evolution. P, 1b or junior standing in anthropology, botany, or geology.

320. Advanced Studies in Invertebrate Zoology and Parasitology (2) I  
Mead
Examination and discussion of advanced information in the fields of invertebrate zoology and parasitology. P, 220 or 229. May be repeated for credit.

330. Advanced Biology of the Cold-Blooded Vertebrates (2) I  
Lowe
Analysis and synthesis of investigations treating the biology of fishes, amphibians, and reptiles. P, 252 or 253. May be repeated for credit.

335. Selected Studies of Mammals (3) I  
Cockrum
Recent advances in mammalogy. 2R, 3L or field trip. P, 235. Fee, $5. May be repeated for credit.

340. Advanced Vertebrate Morphology (3) I 1960-61  
Chiasson
Comparative anatomy, evolution, and function of vertebrate organ systems for the advanced students of vertebrate zoology. Lectures, reports, and discussions. 2R, 3L. P, 145 and 147. Fee, $10. May be repeated for credit.

341a-341b. Advanced Human Anatomy (4-4) Yr.  
McCauley
Detailed dissection of the human body. 12L. P, graduate standing in zoology. Fee, $10.

350. Advanced Topics in Physiology (2) I  
Ferris
Consideration of recent advances in theory and technology in selected fields of physiology. Lecture and laboratory to be arranged. P, 8 units of physiology or biochemistry. May be repeated for credit.

352. Experimental Embryology (4) II  
Bagnara
An analysis of the principles of development with an introduction to the techniques of classical and chemical embryology. 2R, 6L. P, 147, Chemistry 140b. Fee, $10.

354. Advanced Embryology (2) II  
Bagnara
A discussion of the broad problems of development as revealed by recent advances in embryology and endocrinology. The physiological aspects of the problems will be stressed. P, 147, Chemistry 140b. May be repeated for credit.
356. Radiation Zoology (3) II  
   Primarily a laboratory course in advanced techniques in the use of radioactive tracers in physiological zoology and the influence of radiation on animal growth, survival, and genetics. 1R, 6L. P, Physics 150, 12 units of zoology and 6 units of chemistry. Fee, $10.

360. Current Problems in Wildlife Management (1) I, II  
   Discussions and assignments covering current problems; including the biological, economic, esthetic, political, and sociological phases of wildlife management. May be repeated for credit.

370. Genetics in Natural Populations (4) II 1960-61  
   An evolutionary approach to the study of the genetic system. Topics include mutant and chromosomal variability, gene homologies, polymorphism, hybridization, heterosis. Laboratory emphasis on wild populations of Drosophila. 2R, 6L. P, 172, 275. Fee, $10.

375. Speciation (2) II  
   The mechanisms of evolution in the formation of races and species of animals and plants. P, 172 or 174 or 275, or Botany 132. May be repeated for credit.

399. Seminar (0) I, II

INDIVIDUAL STUDIES

299. Special Problems (2 to 4) I, II

400. Research (2 to 8) I, II Maximum total credit permitted, 8 units.

414. Thesis (2 to 8) I, II Maximum total credit permitted, 8 units

420. Dissertation (1 to 9) I, II
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COLLEGE OF BUSINESS AND PUBLIC ADMINISTRATION
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Departments of: Civil Engineering, Electrical Engineering, Mechanical Engineering, Nuclear Engineering, Numerical Analysis.

COLLEGE OF FINE ARTS
School of Music; Departments of: Architecture, Art, Drama, Speech.

COLLEGE OF LAW

COLLEGE OF LIBERAL ARTS
School of Nursing; Departments of: Anthropology, Astronomy, Bacteriology and Medical Technology, Chemistry, Classics, English, German, Government, History, Journalism, Mathematics, Meteorology and Climatology, Philosophy and Psychology, Physics, Romance Languages, Zoology; Committee on Oriental Studies.

COLLEGE OF MINES
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COLLEGE OF PHARMACY

GRADUATE COLLEGE
Committees of: Biochemistry and Nutrition, Geochronology, Public Administration.

GENERAL DEPARTMENTS
School of Military Science and Tactics.
Department of Physical Education for Men.
Department of Physical Education for Women.

SUMMER SESSION

DEPARTMENTS AND AFFILIATIONS OF RESEARCH AND SPECIAL SERVICE
Agricultural Experiment Station, Agricultural Extension Service, Applied Research Laboratory, Arizona Bureau of Mines, Arizona State Museum, Arizona Transportation and Traffic Institute, Association of Universities for Research in Astronomy (AURA, Inc.), Bureau of Audio-Visual Services, Bureau of Business and Public Research, Bureau of Ethnic Research, Cooperative Wildlife Research Unit, Division of Continuing Education, Division of Correspondence Instruction, Engineering Experimental Station, Geochronology Laboratories, Institute of Atmospheric Physics, Institute of Water Utilization, Laboratory of Tree-Ring Research, Numerical Analysis Laboratory, Poisoning Control Information Center, Radio-Television Bureau, Steward Observatory, University Committee on Atmospheric Research.