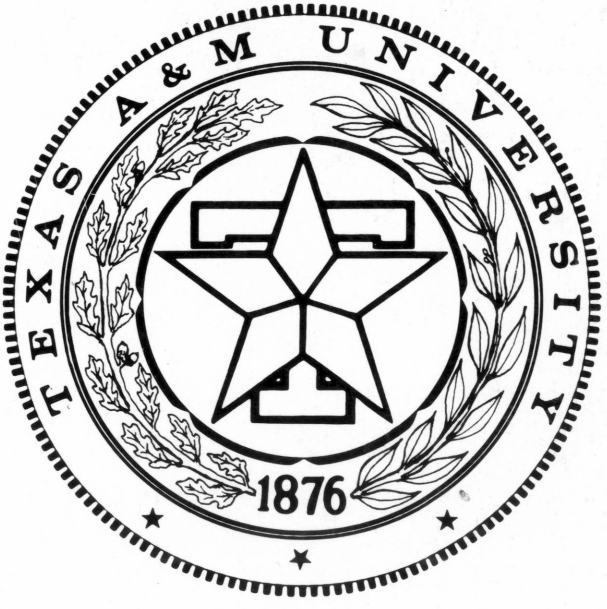

1989-1990 GRADUATE CATALOG

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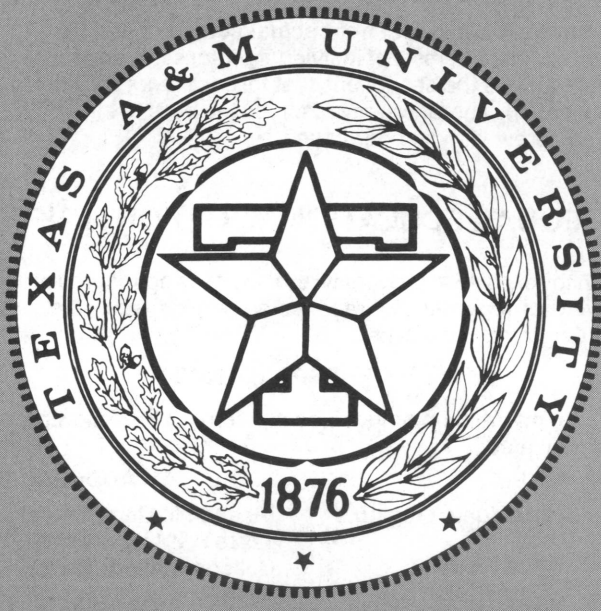
TEXAS A&M UNIVERSITY
GRADUATE CATALOG
1989-1990



PURPOSE

This catalog provides information about the graduate programs of Texas A&M University to students, prospective students, and faculty and staff of the University. Included is information concerning requirements for admission to Graduate Studies at the University, services available to students, graduate course offerings and listings of the administrative officers and the Graduate Faculty.

While every effort has been made to make this catalog as complete and accurate as possible, it should be noted that changes in requirements, deadlines, fees, and courses listed in this catalog may occur at any time.

This catalog was prepared in advance of its effective date. Consequently, course descriptions may vary somewhat from actual course content because of advancements in the discipline, interests of individual professors, or decisions to change the scope of a course. Thus the decriptions that follow are not provided in the nature of a contractual obligation. The University reserves the right to alter or change any statement contained herein without prior notice.

EQUAL EDUCATIONAL OPPORTUNITY

Admission to Texas A&M University and any of its sponsored programs is open to qualified individuals regardless of race, color, religion, sex, age, national origin, or educationally unrelated handicaps.

CORRESPONDENCE

Requests for information or inquiries concerning the following items should be addressed as indicated:

ITEM	ADDRESS TO
Information about graduate programs	(Academic Department) Texas A&M University College Station, Texas 77843
Applications forms and admission information	Office of Admissions and Records Texas A&M University College Station, Texas 77843-0100
Information about required tests and locations	Measurement and Research Services Texas A&M University College Station, Texas 777843-4239
GRE test dates and locations	Graduate Record Examinations Educational Testing Service Box 955-R Princeton, New Jersey 08541-6200
GMAT tests dates and locations	Graduate Management Admission Test Educational Testing Service Box 966-R Princeton, New Jersey 08541-6200
TOEFL test dates and locations	TOEFL Educational Testing Service Princeton, New Jersey 08541-6151 USA

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TEXAS A&M UNIVERSITY
1989-90 ACADEMIC CALENDAR

*Summer Session 1989

June 1-2	Thursday-Friday. Open registration and drop/add for first term and 10-week semester by telephone and by terminal.
June 5	Monday. First day of first term and 10-week semester classes.
June 8	Thursday. Last day for enrolling in the University for the first term and the 10-week semester and for adding new courses. Last day for dropping courses with no record for the first term and 10-week semester.
June 12-16	Monday-Friday. Touch-tone telephone registration for second term by classification.
June 15	Thursday. Last day for undergraduate students to drop courses with no penalty for the first term (Q-drop).
June 16	Friday. For students completing degree requirements the first term, last day to apply for degrees to be awarded in August.
June 23	Friday. Last day for graduate students to drop courses with no penalty for the first term (Q-drop).
June 28	Wednesday. Last day for undergraduate students to drop courses with no penalty for the 10-week semester (Q-drop).
July 4	Tuesday. Independence Day holiday.
July 5-7	Wednesday-Friday. Open registration and drop/add for second term.
July 7	Friday. Last day of first term classes. Beginning of final examinations for the first term, 6-8 p.m.
July 8	Saturday. First term final examinations continue.
July 10	Monday. First day of second term classes.
July 12	Wednesday. First term final grades due in Registrar's Office, 10 a.m.
July 13	Thursday. Last day for enrolling in the University for the second term and for adding new courses. Last day to drop courses with no record for the second term.
July 14	Friday. Last day to apply for all degrees to be awarded in August for students completing degree requirements in the second term or 10-week semester.
July 20	Thursday. Last day for undergraduate students to drop courses with no penalty for the second term (Q-drop).
July 24	Monday. Last day for graduate students to drop courses with no penalty for the 10-week semester (Q-drop).
July 28	Friday. Last day for graduate students to drop courses with no penalty for the second term (Q-drop).
August 10	Thursday. Last day of second term and 10-week semester classes. Beginning of final examinations for the second term and 10-week semester, 6-8 p.m.
August 11	Friday. Second term and 10-week semester final examinations continue. Commencement for all summer session graduating students, 7:30 p.m.
August 12	Saturday. Commencement and Commissioning for all summer session graduating students, 9 a.m.
August 15	Tuesday. Final grades for second term and 10-week semester due in Registrar's Office, 10 a.m.

*These dates are subject to change.

REGULAR SESSION
*Fall Semester 1989

August 21-25	Monday-Friday. Open registration and drop/add for all students.
August 28	Monday. First day of fall semester classes.
August 28-September 1	Monday-Friday. Late registration and drop/add for all students.
September 1	Friday. Last day for enrolling in the University for the fall semester and for adding new courses.
September 12	Tuesday. Last day for dropping courses with no record.
September 15	Friday. Last day to apply for all degrees to be awarded in December.
September 29	Friday. Last day for undergraduate students to drop courses with no penalty (Q-drop).
October 16	Monday. Midsemester grades for freshmen due in Registrar's Office, 10 a.m.
November 3	Friday. Last day for graduate students to drop courses with no penalty (Q-drop).
November 2-December 1	Thursday-Friday. Preregistration for the 1990 spring semester by classification.
November 23-24	Thursday-Friday. Thanksgiving holiday.
December 6	Wednesday. Last day of fall semester classes.
December 7	Thursday. Reading day, no classes. Last day to withdraw officially from the University.
December 8, 11-13	Friday, Monday-Wednesday. Fall semester final examinations for all students.
December 14	Thursday. Commissioning, 10 a.m.
December 15	Friday. Commencement, 7:30 p.m.
December 16	Saturday. Commencement, 9 a.m.
December 18	Monday. Final grades for all students due in Registrar's Office, 12 noon.

*Spring Semester 1990

January 3-12	Wednesday-Friday. Open registration and drop/add for all students.
January 15	Monday. First day of spring semester classes.
January 15-19	Monday-Friday. Late registration and drop/add for all students.
January 19	Friday. Last day for enrolling in the University for the spring semester and for adding new courses.
January 30	Tuesday. Last day for dropping courses with no record.
February 2	Friday. Last day to apply for all degrees to be awarded in May.
February 16	Friday. Last day for undergraduate students to drop courses with no penalty (Q-drop).
March 5	Monday. Midsemester grades for freshmen due in Registrar's Office, 10 a.m.
March 12-16	Monday-Friday. Spring break.
March 23	Friday. Last day for graduate students to drop courses with no penalty (Q-drop).
March 29-April 20	Thursday-Friday. Preregistration for the 1990 fall semester by classification.
April 23-27	Monday-Friday. Preregistration for the 1990 summer session by classification.
May 2	Wednesday. Last day of spring semester classes.
May 3	Thursday. Reading day, no classes. Last day to withdraw officially from the University.
May 4, 7-9	Friday, Monday-Wednesday. Spring semester final examinations for all students.
May 11	Friday. Commencement, 2 p.m. and 7:30 p.m.
May 12	Saturday. Commencement, 9 a.m. Commissioning, 1:30 p.m. and Final Review, 3:15 p.m.
May 14	Monday. Final grades for all students due in Registrar's Office, 12 noon.

*These dates are subject to change.

*Summer Session 1990

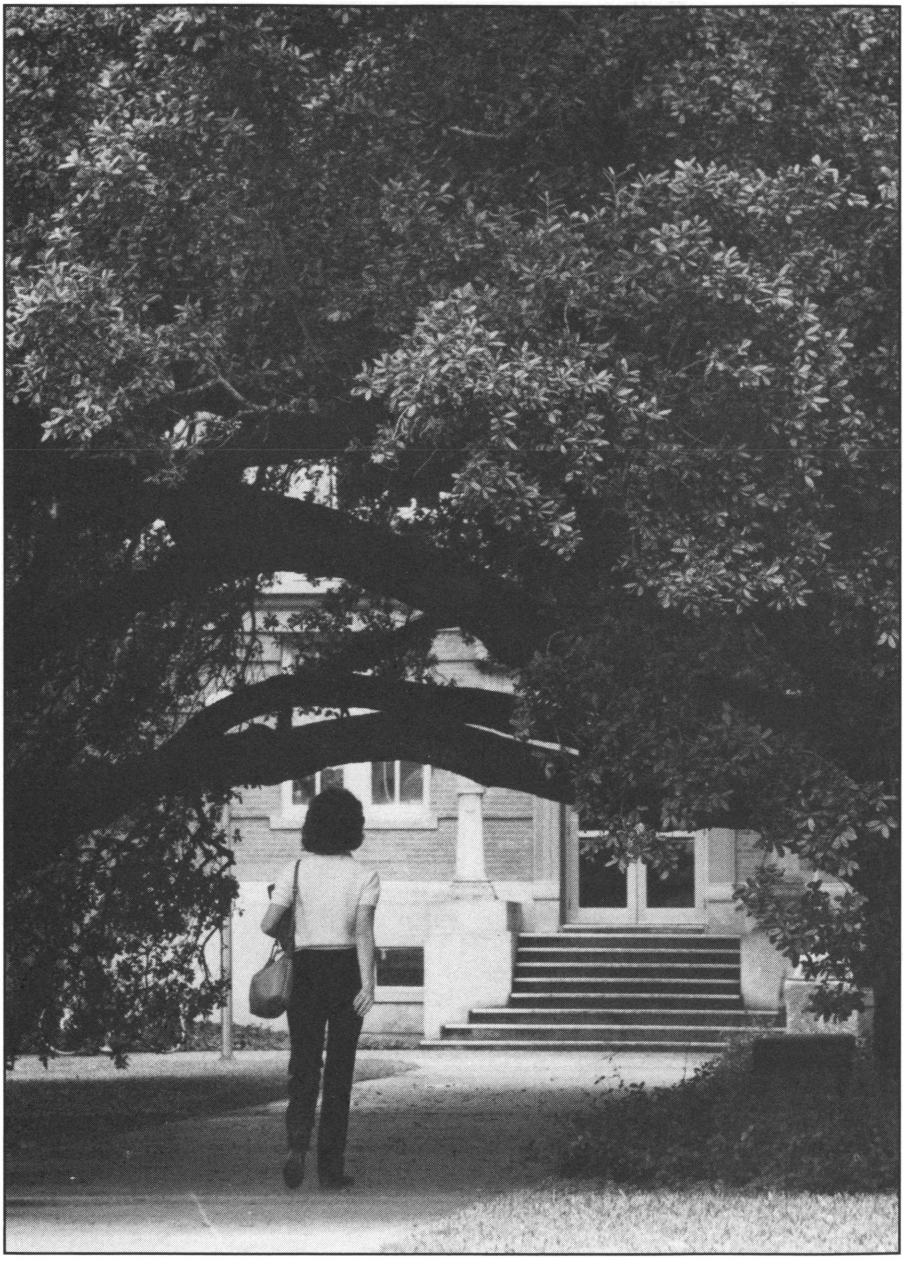
May 28-June 1	Monday-Friday. Open registration and drop/add for first term and 10-week semester by telephone and by terminal.
June 4	Monday. First day of first term and 10-week semester classes.
June 7	Thursday. Last day for enrolling in the University for the first term and the 10-week semester and for adding new courses. Last day for dropping courses with no record for the first term and 10-week semester.
June 11-15	Monday-Friday. Touch-tone telephone registration for second term by classification.
June 14	Thursday. Last day for undergraduate students to drop courses with no penalty for the first term (Q-drop).
June 15	Friday. For students completing degree requirements the first term, last day to apply for degrees to be awarded in August.
June 22	Friday. Last day for graduate students to drop courses with no penalty for the first term (Q-drop).
June 27	Wednesday. Last day for undergraduate students to drop courses with no penalty for the 10-week semester (Q-drop).
July 4	Wednesday. Independence Day holiday.
July 5-6	Thursday-Friday. Open registration and drop/add for second term.
July 6	Friday. Last day of first term classes. Beginning of final examinations for the first term, 6-8 p.m.
July 7	Saturday. First term final examinations continue.
July 9	Monday. First day of second term classes.
July 11	Wednesday. First term final grades due in Registrar's Office, 10 a.m.
July 12	Thursday. Last day for enrolling in the University for the second term and for adding new courses. Last day to drop courses with no record for the second term.
July 13	Friday. Last day to apply for all degrees to be awarded in August for students completing degree requirements in the second term or 10-week semester.
July 19	Thursday. Last day for undergraduate students to drop courses with no penalty for the second term (Q-drop).
July 23	Monday. Last day for graduate students to drop courses with no penalty for the 10-week semester (Q-drop).
July 27	Friday. Last day for graduate students to drop courses with no penalty for the second term (Q-drop).
August 9	Thursday. Last day of second term and 10-week semester classes. Beginning of final examinations for the second term and 10-week semester, 6-8 p.m.
August 10	Friday. Second term and 10-week semester final examinations continue. Commencement for all summer session graduating students, 7:30 p.m.
August 11	Saturday. Commencement and Commissioning for all summer session graduating students, 9 a.m.
August 14	Tuesday. Final grades for second term and 10-week semester due in Registrar's Office, 10 a.m.

*These dates are subject to change.

ACCREDITATION

Texas A&M University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award degrees at the bachelors', masters', doctoral and professional levels. The curriculum in architecture is accredited by the National Architectural Accrediting Board; the curriculum in urban and regional planning is accredited by the Planning Accreditation Board; the curriculum in landscape architecture is accredited by the American Society of Landscape Architects and the curriculum in building construction is accredited by the American Council for Construction Education. The clinical psychology program in the Department of Psychology is accredited by the American Psychological Association. The veterinary medicine degree program is accredited by the American Veterinary Medical Association Council on Education. The medical education degree program is fully accredited by the Liaison Committee on Medical Education. The curriculum in forestry is accredited by the Society of American Foresters, the curriculum in range science is accredited by the Society for Range Management and the food science option in food science and technology and the curriculum in scientific nutrition are certified by the American Dietetic Association. Within the Colleges of Engineering and of Agriculture, the undergraduate programs in aerospace, agricultural, bioengineering, chemical, civil, electrical, industrial, mechanical, nuclear, ocean, petroleum and radiological health engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). The engineering technology program is accredited by the Technology Accreditation Commission of ABET. Both the baccalaureate and the master's curricula in the College of Business Administration are accredited by the American Assembly of Collegiate Schools of Business. Other accrediting agencies which have approved programs offered at the University are the American Chemical Society, the American Society of Agricultural Engineers, the Institute of Food Technologists and the Accrediting Council on Education in Journalism and Mass Communication. Programs in teacher education and degrees conferred by Texas A&M University are approved by the Texas Education Agency for certification and salary qualification purposes and are fully accredited by the National Council for Accreditation of Teacher Education.

TEXAS A&M UNIVERSITY



OFFICE OF GRADUATE STUDIES

STATEMENT OF PURPOSE

Texas A&M University is a public institution dedicated to the development and dissemination of knowledge in many and diversified academic and professional fields. The University is committed to assist students in their search for knowledge, to help them understand themselves and their cultural and physical environments, and to develop in them the wisdom and skills needed to assume responsibility in a democratic society. The University assumes as its historic trust the maintenance and enhancement of an intellectual environment that encourages the development and expansion of the human mind and spirit. While continuing to fulfill its mission as a Land-Grant/Sea-Grant institution, the University is evolving and expanding its role to meet the changing needs of state, national, and international communities. The University aspires to preeminence in teaching, research, and service. In keeping with this statement of purpose of the University, the Office of Graduate Studies: serves as advocate for graduate education within and outside of the University; establishes procedures to guarantee that the educational experience at the graduate level is of the highest quality; fosters and facilitates interdisciplinary/intercollegiate graduate programs and research activities; and strives to maintain and enhance an environment conducive to creative scholarship and scientific inquiry.

GENERAL INFORMATION

In 1888, twelve years after the opening of Texas A&M College, the faculty initiated programs of instruction at the graduate level. In 1890 two Master of Science degrees were conferred without any indication of the specialization of the recipients. Initially, Texas A&M College emphasized graduate programs in agriculture and engineering which were administered by a faculty committee for graduate studies. In 1898 a single Master of Science degree in Horticulture was awarded, followed by a scattering of Master of Science degrees in Agriculture over the next twenty-two years. The acceleration in the awarding of Master of Science degrees after 1920, however, prompted Texas A&M College to establish a Graduate School in 1924, with the Dean of the College serving as Graduate Dean. With the name change to Texas A&M University in 1964, the Graduate School was designated the Graduate College. It was renamed the Office of Graduate Studies in 1987, and is administered by a Director reporting to the Associate Provost for Research and Graduate Studies.

In 1936, the Board of Directors of Texas A&M College approved "certain programs of study and research leading to the doctorate." In the same year the Academic Council of Texas A&M College delineated qualifications required of the faculty for participation in graduate instruction, thereby establishing the Graduate Faculty. The first Ph.D. degree was awarded in 1940. In the 1960's the Board of Regents envisioned a broader role for graduate studies and implemented changes that resulted in programs of graduate instruction in all of the academic colleges throughout the University.

GRADUATE PROGRAMS

Texas A&M University now offers eleven different master's degrees and four different doctoral degrees. Under the eleven master's degrees there are 146 different majors or options available, while approximately 105 different majors are available under the four doctoral degrees. These are listed below.

Degrees

Master of Agriculture (M.Agr.)
Master of Architecture (M.Arch.)
Master of Arts (M.A.)
Master of Business Administration (M.B.A.)
Master of Computer Science (M.C.S.)
Master of Education (M.Ed.)
Master of Engineering (M.Eng.)
Master of Landscape Architecture (M.L.A.)
Master of Public Administration (M.P.A.)
Master of Science (M.S.)
Master of Urban Planning (M.U.P.)
Doctor of Education (Ed.D.)
Doctor of Engineering (D.Eng.)
Doctor of Environmental Design (D.E.D.)
Doctor of Philosophy (Ph.D.)

GRADUATE DEGREE OFFERINGS (BY COLLEGE)

College of Agriculture and Life Sciences

Agricultural Chemistry	M.Agr.			
Agricultural Development	M.Agr.			
Agricultural Economics	M.Agr.	M.S.		Ph.D.
Agricultural Education	M.Ed.	M.S.	Ed.D.	Ph.D.
Agricultural Engineering	M.Eng.	M.S.		Ph.D.
Agronomy	M.Agr.	M.S.		Ph.D.
Animal Breeding		M.S.		Ph.D.
Animal Science	M.Agr.	M.S.		Ph.D.
Biochemistry		M.S.		Ph.D.
Biophysics		M.S.		
Dairy Science	M.Agr.	M.S.		Ph.D.
Economic Entomology	M.Agr.			
Entomology		M.S.		Ph.D.
Fisheries Science	M.Agr.			
Floriculture	M.Agr.	M.S.		
Food Science and Technology	M.Agr.	M.S.		Ph.D.
Forestry		M.S.		Ph.D.
Genetics		M.S.		Ph.D.
Horticulture	M.Agr.	M.S.		Ph.D.
Land Economics and Real Estate	M.Agr.			
Mechanized Agriculture	M.Agr.			
Natural Resources Development	M.Agr.			
Nutrition		M.S.		Ph.D.
Physiology of Reproduction		M.S.		Ph.D.
Plant Breeding		M.S.		Ph.D.
Plant Pathology		M.S.		Ph.D.

Plant Physiology		M.S.		Ph.D.
Plant Protection	M.Agr.			
Plant Sciences	M.Agr.			
Poultry Science	M.Agr.	M.S.		Ph.D.
Range Science	M.Agr.	M.S.		Ph.D.
Recreation and Resources Development	M.Agr.	M.S.		Ph.D.
Rural Sociology	M.Agr.			
Soil Science		M.S.		Ph.D.
Wildlife Science	M.Agr.			
Wildlife and Fisheries Sciences		M.S.		Ph.D.

College of Architecture

Architecture	M.Arch.			Ph.D.
Construction Management		M.S.		
Land Development		M.S.		
Landscape Architecture	M.L.A.		D.E.D.	
Urban and Regional Planning	M.U.P.			
Urban and Regional Science				Ph.D.

College of Business Administration

Accounting		M.S.		Ph.D.
Business Administration	M.B.A.			
Business Analysis				Ph.D.
Business Computing Science		M.S.		
Finance		M.S.		Ph.D.
Management		M.S.		Ph.D.
Marketing		M.S.		Ph.D.

College of Education

Adult and Extension Education	M.Ed.	M.S.	Ed.D.	Ph.D.
Counseling Psychology				Ph.D.
Curriculum and Instruction	M.Ed.	M.S.	Ed.D.	Ph.D.
Educational Administration	M.Ed.	M.S.	Ed.D.	Ph.D.
Educational Psychology	M.Ed.	M.S.	Ed.D.	Ph.D.
Educational Technology	M.Ed.			
Health Education	M.Ed.	M.S.	Ed.D.	Ph.D.
Industrial Education	M.Ed.	M.S.	Ed.D.	Ph.D.
Physical Education	M.Ed.	M.S.	Ed.D.	Ph.D.
School Psychology				Ph.D.
Vocational Education	M.Ed.		Ed.D.	Ph.D.

College of Engineering

Aerospace Engineering	M.Eng.	M.S.		Ph.D.
Agricultural Engineering	M.Eng.	M.S.		Ph.D.
Bioengineering	M.Eng.	M.S.		Ph.D.
Chemical Engineering	M.Eng.	M.S.		Ph.D.
Civil Engineering	M.Eng.	M.S.		Ph.D.
Computer Science	M.C.S.	M.S.		Ph.D.
Electrical Engineering	M.Eng.	M.S.		Ph.D.
Engineering	M.Eng.		D.Eng.	
Health Physics		M.S.		
Industrial Engineering	M.Eng.	M.S.		Ph.D.
Industrial Hygiene		M.S.		
Interdisciplinary Engineering		M.S.		Ph.D.

continued

Mechanical Engineering	M.Eng.	M.S.	Ph.D.
Nuclear Engineering	M.Eng.	M.S.	Ph.D.
Ocean Engineering	M.Eng.	M.S.	Ph.D.
Petroleum Engineering	M.Eng.	M.S.	Ph.D.
Safety Engineering		M.S.	

College of Geosciences

Geography		M.S.	Ph.D.
Geology		M.S.	Ph.D.
Geophysics		M.S.	Ph.D.
Meteorology		M.S.	Ph.D.
Oceanography		M.S.	Ph.D.

College of Liberal Arts

Anthropology		M.A.	Ph.D.
Economics		M.S.	Ph.D.
English		M.A.	Ph.D.
History		M.A.	Ph.D.
Philosophy		M.A.	
Political Science		M.A.	Ph.D.
Psychology		M.S.	Ph.D.
Public Administration	M.P.A.		
Sociology		M.S.	Ph.D.
Spanish		M.A.	

College of Medicine

Genetics		M.S.	Ph.D.
Medical Sciences		M.S.	Ph.D.

College of Science

Biology		M.S.	Ph.D.
Botany		M.S.	Ph.D.
Chemistry		M.S.	Ph.D.
Genetics		M.S.	Ph.D.
Mathematics		M.S.	Ph.D.
Microbiology		M.S.	Ph.D.
Physics		M.S.	Ph.D.
Statistics		M.S.	Ph.D.
Zoology		M.S.	Ph.D.

College of Veterinary Medicine

Epidemiology		M.S.	
Food Science and Technology		M.S.	Ph.D.
Genetics		M.S.	Ph.D.
Laboratory Animal Medicine		M.S.	
Toxicology		M.S.	Ph.D.
Veterinary Anatomy		M.S.	Ph.D.
Veterinary Medical Sciences		M.S.	Ph.D.
Veterinary Medicine and Surgery		M.S.	
Veterinary Microbiology		M.S.	Ph.D.
Veterinary Parasitology		M.S.	
Veterinary Pathology		M.S.	Ph.D.
Veterinary Physiology		M.S.	Ph.D.
Veterinary Public Health		M.S.	Ph.D.

OBJECTIVES OF GRADUATE STUDIES

Graduate students at Texas A&M University are admitted for graduate study in one of the programs listed on the preceding pages. Such programs are usually identified with a particular department. In some cases a program may involve course work and research activities in several departments. Each department has one or more Graduate Advisors who can provide information about specific programs within that department.

A student's program of graduate study usually consists of a combination of course work, independent study, and scholarly research resulting in a report, record of study, master's thesis, or doctoral dissertation. In some programs, students may be required to participate in internship or other professional activity to satisfy particular degree requirements. Some departments require student's participation in teaching as part of their degree programs.

The overall objective of graduate study is to provide students with the intellectual depth and breadth, and appropriate training necessary to pursue productive careers in the professions and in various fields of teaching and research and in other ways make a larger contribution to society than would be otherwise possible.

ADMINISTRATION OF GRADUATE STUDIES

The Graduate Faculty consists of the President, the Provost and Vice President for Academic Affairs, the Associate Provosts, the Director of the Office of Graduate Studies, the Deans of all subject-matter colleges, selected Directors, and a properly qualified academic group appointed by the Office of Graduate Studies. Members of the Graduate Faculty participate in the graduate degree programs of the University by serving on student advisory committees and teaching graduate courses. Individuals who are not members of the Graduate Faculty of Texas A&M University may not teach graduate courses or serve on student advisory committees unless special approval is granted by the Office of Graduate Studies.

The Graduate Council is a standing committee of the Faculty Senate and serves as advisory body to the Associate Provost for Research and Graduate Studies, who is the chief administrative officer of the Graduate Faculty. Each College has a Committee on Graduate Instruction with the responsibility for making recommendations concerning graduate course offerings, general policies on graduate instruction, and for other matters pertaining to graduate studies in that College. The Chair of each Committee on Graduate Instruction is a member of the Graduate Council.

The Graduate Student Council is an advisory body to the Associate Provost for Research and Graduate Studies and is composed of graduate student representatives to the Student Government of the University. It also serves, through the Office of Graduate Studies, as a communication link between graduate students and the University administration.

COOPERATIVE GRADUATE PROGRAMS

Texas A&M University has executed Memoranda of Agreement establishing cooperative graduate programs with the following universities: Baylor College of Medicine, Lamar University, Sam Houston State University, Stephen F. Austin State University, Southwest Texas State University, Tarleton State University, and Texas A&I University. Details concerning these cooperative graduate programs are available from the graduate deans of the institutions involved.

Texas A&M University and The University of Texas System have also entered into an agreement relating to cooperative use of courses and facilities in graduate education. See section on "Texas A&M University — Baylor College of Medicine, The University of Texas System" in the course description section.

STUDENT RESPONSIBILITY

It is the responsibility of each student to:
(1) know specific degree requirements as set down by the Office of Graduate Studies or the student's department;
(2) enroll in the appropriate course work to complete the degree plan; and
(3) maintain the appropriate standards to continue in Graduate Studies.

Information about general degree requirements is available in this catalog. Specific degree requirements and procedural guidelines are available from the departmental Graduate Advisor.

GRADUATE ADVISORS

A graduate student entering the University for the first time is required to consult with a Graduate Advisor in his or her department. Departmental Graduate Advisors are available for consultation several days prior to registration.

PETITIONS

Exceptions to published rules may be requested by proper petition to the Office of Graduate Studies. Each petition will be considered on its own merit by the Director of the Office of Graduate Studies. Signatures of all members of the graduate student's Advisory Committee, if appointed, are required on a petition. Furthermore, the signature of the Department Head, or his or her designee, is required on all petitions, except that petitions from graduate students working on a degree supervised by a Senate-approved Intercollegiate Faculty require the signature of the Faculty Chair, rather than that of the Department Head.

DEGREE PLAN

A graduate student must file a degree plan which includes those courses to be applied toward a particular degree. Changes in the approved degree plan may be made by petition to the Office of Graduate Studies.

Additional course work may be added to the approved degree plan by the student's Advisory Committee. Specific details are indicated under the description of requirements for each degree program.

SCHOLARSHIP

Graduate students must maintain a minimum grade point ratio (GPR) of 3.00 (B average based on a 4.00 scale) in all course work. Courses in which grades of Satisfactory (S) or Unsatisfactory (U) are given are 681, 684, 690, 691, 692, 693, 695. No other course may be taken S/U. The GPR is computed by using all graduate courses taken since being admitted to the current degree program and all undergraduate and transfer courses listed on the degree plan.

Grades of D, F, or Unsatisfactory (U) for courses on the degree plan must be absolved by repeating the courses and achieving grades of C or above or Satisfactory (S). A course in which the final grade is a C may be repeated for a higher grade. Semester credit hours to which grades of Withdraw Failing (WF) and F are assigned shall be included in computing the GPR. Those involving grades of Withdraw Passing (WP) and Q-drop (Q) shall be excluded.

If a student's cumulative GPR falls below the minimum of 3.00, he or she will be considered to be on scholastic probation. If the minimum GPR is not attained in a reasonable time, the student will be dropped from Graduate Studies.

FULL-TIME STATUS

A graduate student is considered **full-time** if he or she is registered for a minimum of:

9 semester credit hours during a fall or spring semester,
6 semester credit hours during a 10-week summer semester, or
3 semester credit hours during a 5-week summer term.

FINANCIAL ASSISTANCE

Assistantships. Graduate assistantships, both teaching and non-teaching, are available to qualified students on a competitive basis. Assistantships require service up to one-half time (20 hours a week). Appointment to assistantships is normally for nine months, although some may be available for up to twelve months. Most assistantships are awarded through the applicant's major department. Applicants should contact the Department Head or Graduate Advisor concerning the availability of assistantships.

Graduate students must register for the appropriate number of university semester credit hours to maintain full-time status *(see above)* during any semester or summer term in which they hold an assistantship.

Fellowships. Highly competitive fellowships are available to graduate students with outstanding records. Ordinarily, graduate students holding fellowships are not required to perform any services. Graduate students holding fellowships administered through the Office of Graduate Studies must register for a minimum of:

12 semester credit hours during a fall or spring semester
10 semester credit hours during a 10-week summer semester
5 semester credit hours during a 5-week summer term

Unless specifically excluded by the conditions of the fellowship award, students holding fellowships administered through the Office of Graduate Studies may concurrently hold assistantships requiring service up to one-quarter time (10 hours per week). Graduate students concurrently holding a fellowship with a one-quarter time assistantship normally have the same registration requirements as students holding one-half time assistantships.

Colleges and departments may impose additional semester credit hour requirements for students holding assistantships or fellowships which exceed the minima stated above.

Graduate students in either non-degree status or probationary status are not eligible for graduate assistantships or fellowships.

Student Financial Aid Office

Programs available to graduate students through the Office of Student Financial Aid include the National Direct Student Loan (NDSL), Guaranteed Student Loan (GSL), Hinson-Hazlewood Loan, PLUS loan, State Student Incentive Grant (SSIG), Texas Public Education Grant (TPEG), college work-study (CW-S), regular part-time employment and emergency short term loans. A student must be full-time in order to be considered for financial aid. Details and eligibility requirements on these programs may be found in the Student Financial Aid brochure. Students who wish to apply for financial assistance must submit either a Financial Aid Form (FAF) to the College Scholarship Service or a Family Financial Statement (FFS) to the American College Testing prior to April 15 for the fall semester and/or academic year and September 15 for the spring semester. Employment leads for on and off campus jobs are available in the lobby of the Student Financial Aid Office. Financial Aid Forms, Loan Applications and brochures are available upon request from the Student Financial Aid Office, 2nd Floor, Pavilion, Texas A&M University, College Station, TX 77843-1252; (409/845-3236).

Graduate students should address their inquiries and requests for applications, Financial Aid Forms, the Student Financial Aid brochure, and other information to the Director of Student Financial Aid, Texas A&M University, 2nd floor, The Pavilion, College Station, TX 77843-1252.

PROFESSIONAL INTERNSHIPS

In those programs in which a professional internship is used*, a student will spend an appropriate period of time under the supervision of a practicing professional in industry, business, an educational institution or a government agency. The objectives of the internship are two-fold: (1) to enable the student to demonstrate the ability to apply both technical training and knowledge by making an identifiable contribution in an area of practical concern to the industry or organization in which the internship is served, and (2) to enable the student to function in a non-academic environment in a position in which he or she will become aware of the organizational approach to problems in addition to those traditional approaches with which the student is familiar. These may include, but are in no way limited to, problems of management, labor relations, public relations, environmental protection, economics, etc.

Internship agreements should be negotiated between the appropriate organization or industry and the appropriate academic department. Copies of such agreements are to be provided to the Office of Graduate Studies. The organization of the internship, the internship supervisor and the nature of the internship will be determined by mutual consent of the student, the head of the student's major department, the student's Advisory Committee and the supervising organization prior to the commencement of the internship period. The internship experience should be at a level commensurate with the particular degree objective.

An internship report should be prepared by the student in accordance with guidelines established by the student's major department, the student's Advisory Committee or other appropriate body. The report should be submitted to the Advisory Committee and to any other organization which may be specified for specific programs. The internship report must be the original work of the student.

An internship, if utilized as part of a student's degree requirements, should be undertaken near the end of the student's educational program, after the student has had the opportunity to establish a solid theoretical base for the internship experience.

*Master's programs: M.Agr., M.Arch., M.B.A., M.C.S., M.Ed., M.Eng., M.L.A., M.P.A., M.U.P.
Doctoral programs: Ph.D., Ed.D., D.Eng., D.E.D.

TEACHER CERTIFICATION

Programs leading to teacher certification are available through the College of Education. Initial teaching certificates, enabling candidates to teach in the public schools of Texas, can be earned through extended programs which commence with undergraduate studies leading to the baccalaureate degree and which culminate with the completion of selected graduate courses. Graduate courses used to satisfy certification requirements in these extended programs may be used toward satisfying the requirements for the master's degree. Candidates seeking teacher certification through extended programs must be fully admitted to graduate study as degree seeking candidates. For more information on these programs, please review appropriate material in the *Undergraduate Catalog* or consult with advisors in the College of Education. Individuals who already hold a baccalaureate degree in a field other than education and who wish to acquire an initial teaching certificate should contact the Teacher Certification Office in the College of Education. Professional Certificate programs, such as school counseling, administration, and supervision, are offered at the graduate level and are available through academic departments in the College of Education. Please see the program descriptions of these departments in this catalog.

RESIDENCE REQUIREMENTS

A major purpose of the residence requirements for graduate degrees is to insure that the student has an opportunity to benefit from the advantages of a university environment. These advantages include not only the accessibility of library, laboratory, and other physical facilities, but also the opportunity to participate in seminars and a variety of cultural activities. Equally important to the graduate student are the advantages of becoming acquainted with the faculty and other students on both a cultural and a professional basis.

A student "in residence" is expected to devote most of his or her time and energy to graduate studies **on the main campus under the direction of the student's major professor and the Advisory Committee.**

Another major purpose of the residence requirements for graduate degrees is to insure the faculty the opportunity to properly evaluate the student and his or her development in order to guide and direct his or her studies and to determine competency.

The minimum time required to qualify for an advanced degree varies with the ability and preparation of the student. Students may find it necessary to extend their studies beyond the minimum requirements. Specific minimum residence requirements are indicated in connection with the respective degrees.

LETTER OF INTENT

Every student completing a master's degree who plans to continue into a doctoral program must have a letter of intent, approved by the appropriate department head, on file with the Office of Graduate Studies. This letter should be on file the first semester the student is enrolled after completing the master's degree.

ADMISSION TO GRADUATE STUDIES

GENERAL INFORMATION

A formal application is required of all persons seeking admission to Graduate Studies. Requests for application forms and inquiries regarding admission may be obtained by writing the Office of Admissions and Records at the address given in the front of this catalog. Information about enrollment procedures for students from other countries is incorporated into a pamphlet entitled *"Information for Prospective International Students"* available from the Office of Admissions and Records.

A $25 fee is required of U.S. citizens who are applying or reapplying to Graduate Studies. The fee may be waived only in exceptional cases for low-income applicants. In such cases, applicants should include with the application for admission a letter from their financial aid officer or other knowledgeable officer verifying the need for a waiver.

Admission to Graduate Studies normally remains valid for one year from the date of acceptance with one $25 application fee. An extension to the one-year time limit may be granted, if requested by the applicant in writing.

Departments may have admission requirements in addition to those of the Office of Graduate Studies. In such cases, higher departmental standards (e.g., grade-point ratio or GRE scores) replace those of the Office of Graduate Studies.

The normal requirement for admission to Graduate Studies is a scholastic record which, over at least the last two years of full-time academic study, gives evidence of the applicant's ability to do successful graduate level work.

An applicant whose academic record is not satisfactory, or who is changing fields of study, may be required to take additional work in preparation for graduate study. Such work will normally be arranged in conference with the Graduate Advisor or the Head of the student's major department. Before accepting a student for graduate study, a department may require that the student pass a comprehensive examination covering the basic undergraduate work in that field.

To allow time for processing, application forms should be filed at least six weeks prior to the opening of the semester. Admission to Graduate Studies cannot be completed until all the credentials requested in the application form have been received and evaluated.

In addition to the records sent to the Office of Admissions and Records, students should have in their possession a copy of their record for use in conferences with the Graduate Advisor or Graduate Faculty in their department.

Admission to Graduate Studies may not be approved in instances where the facilities and staff available in the particular field are not adequate to take care of the needs of the student.

REGULAR

To be admitted to Graduate Studies an applicant must:

(1) Hold a four-year baccalaureate degree from a college or university of recognized standing (i.e., a degree recognized as equivalent to a baccalaureate degree awarded in the U.S.);

(2) Show promise of ability to pursue advanced study and research satisfactorily;

(3) Have had adequate preparation to enter graduate study in the field chosen; and

(4) Submit with the application acceptable scores on the General Test of the Graduate Record Examination (GRE), except as follows: the Graduate Management Admission Test (GMAT) is required for all applicants to the Master of Business Administration and Master of Science in Business Administration degree programs. Applicants intending to work toward a Ph.D. in the College of Business Administration or to major in agricultural economics, public administration or land development may take either the GRE or GMAT. With the

approval of the department concerned, master's degree recipients from Texas A&M University who were unanimously recommended for doctoral study by their master's degree Advisory Committee will not be required to retake the GRE or GMAT where used. Approximately six weeks are required for scores to be received by the Office of Graduate Studies after the tests are administered. Scores made on the GRE or GMAT more than five calendar years prior to application for admission to Graduate Studies may not normally be used to satisfy admission requirements.

During 1989-90 the GRE and GMAT will be given at various centers, including Texas A&M University, throughout the United States and in other countries. To determine the most convenient locations to take either the GRE or GMAT, prospective applicants should write to either the appropriate division of the Educational Testing Service, Princeton, N.J., or to Measurement and Research Services, Texas A&M University at the address given in the front of this catalog.

INTERNATIONAL

An applicant from another country seeking admission to Graduate Studies must meet the same requirements for admission as applicants from the United States; namely, (1) - (4) above. In addition, he or she must demonstrate the ability to speak, write and understand the English language. Prospective students whose native language is not English must take the Test of English as a Foreign Language (TOEFL), which is administered by the Educational Testing Service in over 200 centers around the world. A registration form and a "Bulletin of Information for Candidates" may be obtained by writing the appropriate division of the Educational Testing Service. All applicants from non-English-speaking countries must present a score of at least 550 on the TOEFL in order to be admitted to Graduate Studies.

All graduate students whose native language is not English must complete an English Proficiency Certification Process regardless of their TOEFL scores or other indications of English language proficiency. The certification process should begin early in a student's graduate program, and **must be completed** prior to the scheduling of either the final examination for the master's degree, or the preliminary examination for the doctoral degree. A student must complete the English certification process prior to holding a teaching assistantship.

A student can complete the English Proficiency Certification Process by one of the following methods:

Scoring 80 or higher on each of the six (6) parts of the English Language Proficiency Examination (ELPE).

Earning a B or better in the advanced level of the required course in the English Language Institute (ELI).

Alternative certification on the basis of credentials or other evidence approved by the Director, Office of Graduate Studies.

No student from another country may be admitted to Texas A&M University as a non-degree student or register in non-degree status.

The following application deadlines have been established for all **International applications:**

February 1 for the fall semester
September 1 for the spring semester
February 1 for the summer session.

PROBATIONARY

Students who fail initially to qualify for admission to Graduate Studies but who aspire to work for advanced degrees may, upon the department's recommendation, be given a probationary period in which to demonstrate their ability to do graduate work. Any student who successfully completes a probationary program will be allowed to use all course work for degree credit if approved by the student's Advisory Committee, the Head of the student's major department, and the Office of Graduate Studies (i.e., approval of the degree plan). International students are not accepted on probation.

NON-DEGREE

Students, other than international students, who hold baccalaureate and advanced degrees and who have not gained admission either to a master's or doctoral program may be permitted to enroll initially in Texas A&M University at the post-baccalaureate level for one semester or one summer session as non-degree graduate students (classification 6). Admission of non-degree graduate students to departments and courses is subject to individual departmental policy. Non-degree graduate students are not normally allowed to enroll in graduate courses in the College of Business Administration.

Continued registration as a post-baccalaureate, non-degree graduate student is contingent upon satisfactory academic performance each semester.

Graduate credit normally will not be allowed for any course unless the student has been granted admission to Graduate Studies and is registered therein when the course is taken. In case of unusual circumstances a maximum of 9 credit hours taken prior to admission to Graduate Studies may be used on the degree plan.

Every non-degree graduate student must attain a 2.50 GPR on the initial 12 credit hours of course work for which the student enrolls and must maintain a 2.50 GPR thereafter in order to remain eligible to register.

SENIOR CITIZENS

Senior citizens, 65 years old or older, may audit courses with the permission of the instructor, if space is available in the assigned classroom. It is not necessary for these people to be admitted to the University and academic records of their attendance will not be maintained.

REGISTRATION

General. Prior to the first registration, a student should seek assistance from the Graduate Advisor representing the field of his or her major interest. This advisor will assist in planning the student's first registration. Registration requirements for graduate students holding fellowships or graduate assistantships are discussed in the section on Financial Assistance.

In Residence. Resident graduate students who have completed all course work on their degree plans, but who are still engaged in research for their theses, dissertations or records of study must register for a minimum of 4 credit hours of 691 (Research) or 692 (Professional Study) each subsequent fall and spring semester, and each 10-week summer session until all requirements for the degree have been completed.

In Absentia. Students in graduate degree programs requiring a thesis, dissertation, internship, or record of study, who have completed all course work on their degree plans other than 691 (Research), 684 (Internship), or 692 (Professional Study), are required to register ***in absentia*** each subsequent fall and spring semester for a minimum of 4 credit hours of 691, 684, or 692, respectively, until all requirements for the degree have been completed.

Leave of Absence. Under unusual circumstances, a student may petition for a leave of absence. The entire student Advisory Committee and Head of the Department must approve the petition. If the petition is approved, the registration requirement will be set aside during the period of leave. Leaves will be granted only under conditions that require the suspension of all activities associated with the thesis, dissertation, or record of study.

Employees Registering as Students. Full details of the conditions under which heads of departments may grant approval of employee requests to enroll as students in the University may be found in the *Policy and Procedures Manual* (2.3.1.15). Study opportunities for faculty and staff are also discussed in the *Faculty-Staff Handbook.*

All employees eligible to receive graduate degrees from the University must meet degree requirements as set forth in this catalog.

Limitations for Staff Members. The following limitations were set by the Academic Council of Texas A&M University concerning advanced degrees for members of the resident staff of the University:

1. Members of the faculty above the rank of assistant professor normally will not be granted the doctoral degree at this institution. They may, however, enroll for graduate work.
2. Members of the faculty normally will not be granted a graduate degree by the University, after receiving tenure at this institution. They may, however, enroll for graduate work.
3. Any exceptions to the above regulations must have the written approval of the concerned department heads, college deans, the Office of Graduate Studies, and the Provost and Vice President for Academic Affairs before the person applies for admission to Graduate Studies.
4. No department is to award a graduate degree to a faculty member above the rank of assistant professor of that same department.

Double Registration. Undergraduates at Texas A&M University who are within 12 hours of graduation may apply for admission to Graduate Studies. Those admitted must complete their undergraduate work and obtain the baccalaureate degree during the first 15-week semester following their admission.

Undergraduates Registering for Graduate Courses. Senior undergraduate students with a grade point ratio of at least 3.0 are eligible to enroll in a graduate course and reserve it for graduate credit by filing a petition approved by the course instructor, their major department head, their subject matter dean, and the Office of Graduate Studies.

Academically superior undergraduate students with a grade point ratio of at least 3.25 are eligible to apply graduate credit hours toward their undergraduate degree program by filing a petition approved by the course instructor, their major department head, their subject matter dean, and the Office of Graduate Studies. Graduate credit hours used to meet the requirements for a baccalaureate degree may not be used to meet the requirements for a graduate degree.

VA Benefits. Veteran students should note that in order to receive full VA benefits they must be registered for not less than nine credit hours of course work each full semester or three credit hours per 5-week summer term.

Course Load Requirements for International (Non-Immigrant) Students. International (non-immigrant) graduate students must be registered for a minimum of nine credit hours each semester. The only time an exception may be made is during a student's final semester when he or she needs to register only for the minimum number of hours required to satisfy degree requirements. If, at any time during a semester, a student drops below the minimum requirements indicated above, the student is in illegal status and subject to deportation.

If a student is required to attend the ELI on a part-time basis, he or she must then also be enrolled in the appropriate number of formal course hours at the University necessary to comply with the Immigration Service requirements stated above.

The law does not require international (non-immigrant) students to enroll during the summer unless their initial entry into the United States is based on admission to an institution for a specified summer term. In such cases, international graduate students must enroll for a minimum of three semester credit hours per summer term.

FINANCIAL INFORMATION

Educational expenses for nine months will vary according to personal needs and course of study. The cost for new students including tuition and fees, books, supplies, transportation, room and board, incidental and living expenses will be approximately $7,850. Total expenses for returning students during an academic year should be slightly less than those for new students. Nonresident students and international students should increase estimated expenses by $2,556 to adjust for nonresident tuition. (See the tuition and required fee tables in this section.) All tuition and fee amounts provided herein represent the most accurate figures available at the time of publication and are subject to change without notice.

Students are expected to meet all financial obligations to the University by designated due dates. Failure to pay amounts owed may result in cancellation of registration and being barred from future enrollment and receiving official transcripts.

Students may pay all obligations to the University with a personal check unless otherwise restricted. Checks in excess of the amount owed, with the balance payable to the student, cannot be accepted. Payment of tuition and fees with a bad check may result in cancellation of the student's registration and restrictions on use of personal checks on campus if not cleared within the time period given.

Tuition, most required fees, and room and board are payable in full or in two or four equal installments. A $10 service charge to cover the cost of handling will be assessed to each student who chooses to use an installment plan. Students may pay their account in full any time during a semester; however, the service fee will not be refunded once a payment is made under either the two or four installment plan. Students who wish to pay fees in installments should contact the Fiscal Department Fee Section at 409/845-8127.

All scholarships, grants and loans are applied to any outstanding charges before installments are calculated.

NOTICE: There are severe penalties for failure to pay installments by their specified due dates. If a payment is delinquent when a semester ends, the student will be removed from the rolls of the University and will not receive credit for academic work performed that semester. Students will not be readmitted to the University until all past due balances, including late charges, are paid. A $10 late fee will be assessed for each payment not received on or before its due date. If a student is removed from the rolls of the University or is withdrawn for failure to pay amounts owed the University, a $50 reinstatement fee will be assessed in addition to any other late fees or penalties already incurred and must be paid before the student will be reinstated.

FEES

REQUIRED FEES

Tuition: Resident students pay $18 per semester credit hour, but the total of such charge shall be not less than $100 per semester or $50 per summer term. Nonresident and international students pay $122 per semester credit hour.

General Use Fee: This fee, at the rate of $6 per semester credit hour, is required of all students to cover bonded indebtedness incurred for the expansion, air conditioning and/or rehabilitation of University facilities.

Computer Access Fee: The computer access fee is charged at the rate of $3 per semester credit hour during the fall and spring semesters and $1.50 per semester credit hour during the summer to insure availability of computing resources to all students at the University. The fee provides for maintenance and expansion of academic computing facilities on campus.

Student Services Fee: All students pay this fee at the rate of $5.70 per semester credit hour (not exceeding $67 per semester, or $33.50 per summer term). It covers medical services and entitles the student to receive *The Battalion* newspaper, reduced admission to many Memorial Student Center programs and services of the Office of the Students' Attorney, the MSC, Student Counseling Service, Student Activities and Intramural-Recreational Sports.

International Student Fee: This $12 fee is required of all international students to offset the cost of services and materials for the special administration of international students such as visa verification, changes and extensions; work permits; socio/cultural/academic adjustments and issuing I-20's for travel.

Student Center Complex Fee: This $20 fee is required of all students for maintaining, improving and equipping the Student Center Complex.

Health Center Fee: This $15 fee is required of all students for the purpose of operating, maintaining and equipping the University Health Center and entitles students to use its services. These services do not include surgical operations or charges for consultations with outside physicians requested by parents.

Identification Card: This $5 fee is required of all students. The I.D. card is used for registration, fee collection, financial aid disbursement, dining hall authorization, library privileges, etc. Replacement I.D.s are $8.

Laboratory Fees: Laboratory fees ranging in amount from $2 to $30 are charged for each laboratory course each semester.

Physical Education Service Fee: All students taking physical education activities courses will be required to pay a $12 service fee for each activity course.

Field Trip Fees: Field trip fees are assessed to cover the cost of providing trips and vary depending on the course taken and expected expenses.

Late Payment Fees: Students who register (including payment of fees) on the first day of University classes and thereafter pay a late fee of $10. Students who fail to pay installments when due are assessed a $10 late payment fee for each installment paid late.

Installment Payment Service Charge: Students who choose to pay using the two or four payment installment plan pay a $10 installment payment service charge. This charge is nonrefundable once a payment has been made.

Reinstatement Fee: Students who fail to pay all fees by the last day of the semester will be administratively withdrawn from the University and charged a $50 reinstatement fee.

OTHER FEES

Diploma Fee (all degree candidates) $15.00
Binding and Collating Fees:
Master's students (thesis option only) $42.50
Doctoral students (includes microfilming fee) $87.50

Sponsored International Students: An administrative fee not to exceed $350 per semester or summer session (all or part thereof) will be required to support international academic participants whose programs are managed under contract with Texas A&M University by the Office of International Agricultural Programs, unless these fees are waived as part of negotiated contractual agreements.

DEPOSITS

Property Deposit: Every student, unless registered *in absentia,* must make a property deposit of $10 to protect the University from damage to or loss of University property. Charges will be billed directly to the student or collected by the department upon re-issue of supplies or property. Failure to pay the charges promptly will cause the student to be barred from readmission and receiving an official transcript from the University. If a student withdraws from the University without paying the charges, the deposit will be held for 30 days after the close of a semester or a student's withdrawal, so that all charges and fines may be totaled from the various departments. This deposit, less outstanding charges, will be returned **upon request** to the student graduating or withdrawing from school. **Deposits not requested within four years from date of last attendance will be forfeited into a student deposit scholarship account.**

STUDENT OPTIONS

Housing: On-campus housing is not available for Graduate students **except** during summer school. Summer school housing information will be available in April. Graduate housing is available in the University-owned Apartments. For more information contact:

University-Owned Apartments Office
Texas A&M University
College Station, TX 77843-3365

Meal Plans: Meal plans vary significantly and refunds are limited. Please read all of the information about the various plans and also the University refund policy prior to requesting a meal plan. Aggie Bucks are included with some plans to allow students the freedom of eating a limited number of meals at any of the various dining facilities on campus in addition to meals at their assigned dining hall. **All meal privileges, including Aggie Bucks, expire at the end of each semester; they do not carry over to the next semester.**

Semester Rates

5-Day Plan 3 meals a day, 5 days a week	$ 727.78 ($ 677 + $50.78 tax)
7-day Plan 3 meals a day, 6 days a week, and breakfast and lunch on Sunday	$ 780.45 ($ 726 + $54.45 tax)
5-Day Plus 3 meals a day, 5 days a week, and $125 in Aggie Bucks	$ 862.15 ($ 802 + $60.15 tax)

continued

7-Day Plus	
3 meals a day, 7 days a week, and $100 in Aggie Bucks	$ 887.95 ($ 826 + $61.95 tax)
Flex-12	
Any 12 meals out of 20 offered during the week and $120 in Aggie Bucks	$ 835.28 ($ 777 + $58.28 tax)
Lucky-7	
7 meals out of 20 offered during the week and $210 in Aggie Bucks	$ 643.93 ($ 599 + $44.93 tax)
Aggie Gold Card	
Up to 4 meals daily in any dining facility on campus; limit of $6.50 on any one meal. Also, $100 in Aggie Bucks	$1,143.80 ($1,064 + $79.80 tax)
Aggie Express	
$350 in Aggie Bucks	$ 376.25 ($ 350 + $26.25 tax)

Serving Hours

Breakfast	6:15 a.m. - 10:15 a.m.
Lunch	10:15 a.m. - 2:15 p.m.
Dinner	4:15 p.m. - 7:00 p.m.

Bus Pass: A bus pass costs $46 per semester. Bus routes cover the campus and various sections of the city. Routes are based on areas where large numbers of students live.

Parking Permit: Students driving motor vehicles on University property must register them at the University Police Department no later than 48 hours after arriving on campus. Costs of parking permits are as follows:

Residence hall students	$ 75
Students living off campus-two semesters	$ 55
Northside Parking Garage	$150
Motorcycle (including mopeds and scooters)-academic year	$ 35

Football Ticket Books: The ticket book charge is based on the number of home games at one-half the regular ticket price on a season ticket basis.

All Sports Pass: The all sports pass provides student tickets for all home sports and is based on the number of home football games at one-half the regular ticket price on a season ticket basis plus $15.

Aggieland (Yearbook): This $20 plus $1.50 sales tax charge is for a copy of the *Aggieland*.

Picture In Yearbook: This $1 charge is for a student's picture in the *Aggieland*.

Student Directory: This $2.50 plus 19¢ sales tax charge is for a student directory.

10-WEEK SUMMER SEMESTER

Students who register for 10-week summer semester courses during first summer term registration are charged the minimum tuition ($100) for a fall or spring semester. The following fees will also be assessed: the maximum Student Services Fee of $67, the Student Center Complex Fee of $20 and the Health Center Fee of $15. If students register for additional courses during the second summer term, fees will be automatically adjusted.

TUITION AND REQUIRED FEES TABLE—FALL AND SPRING SEMESTERS

No. of Hours	Tuition Resident Students	Tuition Nonresident & Internat'l Students	General Use Fee	Computer Access Fee	Student Services Fee	Internt'l Student Fee	Student Center Complex Fee	Health Center Fee	Total Resident Students	Total Nonresident Students	Total Internat'l Students
1	$100.00	$ 122.00	$ 6.00	$ 3.00	$ 5.70	$12.00	$20.00	$ 0.00	$156.70	$ 156.70	$ 168.70
2	$100.00	$ 244.00	$ 12.00	$ 6.00	$11.40	$12.00	$20.00	$ 0.00	$149.40	$ 293.40	$ 305.40
3	$100.00	$ 366.00	$ 18.00	$ 9.00	$17.10	$12.00	$20.00	$ 0.00	$164.10	$ 430.10	$ 442.10
4	$100.00	$ 488.00	$ 24.00	$12.00	$22.80	$12.00	$20.00	$ 0.00	$178.80	$ 566.80	$ 578.80
5	$100.00	$ 610.00	$ 30.00	$15.00	$28.50	$12.00	$20.00	$ 0.00	$193.50	$ 703.50	$ 715.50
6	$108.00	$ 732.00	$ 36.00	$18.00	$34.20	$12.00	$20.00	$15.00	$231.20	$ 855.20	$ 867.20
7	$126.00	$ 854.00	$ 42.00	$21.00	$39.90	$12.00	$20.00	$15.00	$263.90	$ 991.90	$1,003.90
8	$144.00	$ 976.00	$ 48.00	$24.00	$45.60	$12.00	$20.00	$15.00	$296.60	$1,128.60	$1,140.60
9	$162.00	$1,098.00	$ 54.00	$27.00	$51.30	$12.00	$20.00	$15.00	$329.30	$1,265.30	$1,277.30
10	$180.00	$1,220.00	$ 60.00	$30.00	$57.00	$12.00	$20.00	$15.00	$362.00	$1,402.00	$1,414.00
11	$198.00	$1,342.00	$ 66.00	$33.00	$62.70	$12.00	$20.00	$15.00	$394.70	$1,538.70	$1,550.70
12	$216.00	$1,464.00	$ 72.00	$36.00	$67.00	$12.00	$20.00	$15.00	$426.00	$1,674.00	$1,686.00
13	$234.00	$1,586.00	$ 78.00	$39.00	$67.00	$12.00	$20.00	$15.00	$453.00	$1,805.00	$1,817.00
14	$252.00	$1,708.00	$ 84.00	$42.00	$67.00	$12.00	$20.00	$15.00	$480.00	$1,936.00	$1,948.00
15	$270.00	$1,830.00	$ 90.00	$45.00	$67.00	$12.00	$20.00	$15.00	$507.00	$2,067.00	$2,079.00
16	$288.00	$1,952.00	$ 96.00	$48.00	$67.00	$12.00	$20.00	$15.00	$534.00	$2,198.00	$2,210.00
17	$306.00	$2,074.00	$102.00	$51.00	$67.00	$12.00	$20.00	$15.00	$561.00	$2,329.00	$2,341.00
18	$324.00	$2,196.00	$108.00	$54.00	$67.00	$12.00	$20.00	$15.00	$588.00	$2,460.00	$2,472.00
19	$342.00	$2,318.00	$114.00	$57.00	$67.00	$12.00	$20.00	$15.00	$615.00	$2,591.00	$2,603.00
20	$360.00	$2,440.00	$120.00	$60.00	$67.00	$12.00	$20.00	$15.00	$642.00	$2,722.00	$2,734.00
21	$378.00	$2,562.00	$126.00	$63.00	$67.00	$12.00	$20.00	$15.00	$669.00	$2,853.00	$2,865.00

Rates shown are the most current available at the time of printing and are subject to change.
NOTE: Add property deposit, I.D. Card Fee, P. E. Service Fee, Laboratory Fees and optional charges as appropriate.

TUITION AND REQUIRED FEES TABLE—5-WEEK SUMMER TERM

No. of Hours	Tuition Resident Students	Tuition Nonresident & Internat'l Students	General Use Fee	Computer Access Fee	Student Services Fee	Internt'l Student Fee	Student Center Complex Fee	Health Center Fee	Total Resident Students	Total Nonresident Students	Total Internat'l Students
1	$ 50.00	$ 122.00	$ 6.00	$ 1.50	$ 5.70	$ 6.00	$10.00	$ 0.00	$ 73.20	$ 145.20	$ 151.20
2	$ 50.00	$ 244.00	$12.00	$ 3.00	$11.40	$ 6.00	$10.00	$ 0.00	$ 86.40	$ 280.40	$ 286.40
3	$ 54.00	$ 366.00	$18.00	$ 4.50	$17.10	$ 6.00	$10.00	$ 7.50	$111.10	$ 423.10	$ 429.10
4	$ 72.00	$ 488.00	$24.00	$ 6.00	$22.80	$ 6.00	$10.00	$ 7.50	$142.30	$ 558.30	$ 564.30
5	$ 90.00	$ 610.00	$30.00	$ 7.50	$28.50	$ 6.00	$10.00	$ 7.50	$173.50	$ 693.50	$ 699.50
6	$108.00	$ 732.00	$36.00	$ 9.00	$33.50	$ 6.00	$10.00	$ 7.50	$204.00	$ 828.00	$ 834.00

TUITION AND REQUIRED FEES TABLE—10-WEEK SUMMER SEMESTER

No. of Hours	Tuition Resident Students	Tuition Nonresident & Internat'l Students	General Use Fee	Computer Access Fee	Student Services Fee	Internt'l Student Fee	Student Center Complex Fee	Health Center Fee	Total Resident Students	Total Nonresident Students	Total Internat'l Students
1	$100.00	$ 122.00	$ 6.00	$ 1.50	$ 5.70	$12.00	$20.00	$ 0.00	$133.20	$ 155.20	$ 167.20
2	$100.00	$ 244.00	$12.00	$ 3.00	$11.40	$12.00	$20.00	$ 0.00	$146.40	$ 290.40	$ 302.40
3	$100.00	$ 366.00	$18.00	$ 4.50	$17.10	$12.00	$20.00	$ 0.00	$159.60	$ 425.60	$ 437.60
4	$100.00	$ 488.00	$24.00	$ 6.00	$22.80	$12.00	$20.00	$ 0.00	$172.80	$ 560.80	$ 572.80
5	$100.00	$ 610.00	$30.00	$ 7.50	$28.50	$12.00	$20.00	$ 0.00	$186.00	$ 696.00	$ 708.00
6	$108.00	$ 732.00	$36.00	$ 9.00	$34.20	$12.00	$20.00	$15.00	$222.20	$ 846.20	$ 858.20
7	$126.00	$ 854.00	$42.00	$10.50	$39.90	$12.00	$20.00	$15.00	$253.40	$ 981.40	$ 993.40
8	$144.00	$ 976.00	$48.00	$12.00	$45.60	$12.00	$20.00	$15.00	$284.60	$1,116.60	$1,128.60
9	$162.00	$1,098.00	$54.00	$13.50	$51.30	$12.00	$20.00	$15.00	$315.80	$1,251.80	$1,263.80
10	$180.00	$1,220.00	$60.00	$15.00	$57.00	$12.00	$20.00	$15.00	$347.00	$1,387.00	$1,399.00
11	$198.00	$1,342.00	$66.00	$16.50	$62.70	$12.00	$20.00	$15.00	$378.20	$1,522.20	$1,534.20
12	$216.00	$1,464.00	$72.00	$18.00	$67.00	$12.00	$20.00	$15.00	$408.00	$1,656.00	$1,668.00

Rates shown are the most current available at the time of printing and are subject to change.
NOTE: Add property deposit, I.D. Card Fee, P. E. Service Fee, Laboratory Fees and optional charges as appropriate.

WITHDRAWAL FROM THE UNIVERSITY

Once a payment for tuition and fees has been accepted by the University, a student is considered officially enrolled unless the student is otherwise restricted from enrolling. Stopping payment on a check for fees or allowing the check to be returned unpaid by the bank for any reason does not constitute official withdrawal. Failure to follow procedures for withdrawing from the University may result in financial penalties and delays with future enrollment in the University.

Once a student registers, he or she is responsible for the total fees assessed regardless of whether an installment option is used. Refund percentages are applied to total fees assessed and not the amount paid. This means that students who withdraw before paying all installments may, in the event of withdrawal, receive a bill with a balance due rather than a refund.

REFUNDS

Refund of fees shall be made to students officially withdrawing from the University or dropping options included below according to the following withdrawal schedule:

Tuition, General Use Fee, Computer Access Fee, Student Services Fee, International Student Fee, Student Center Complex Fee, Health Center Fee, Physical Education Service Fee, Laboratory Fee

Fall, Spring or 10-Week Summer Semester

Prior to the first class day	100 percent
During the first five class days	80 percent
During the second five class days	70 percent
During the third five class days	50 percent
During the fourth five class days	25 percent
After the fourth five class days	None

5-Week Summer Term

Prior to the first class day	100 percent
During the first, second or third class day	80 percent
During the fourth, fifth or sixth class day	50 percent
Seventh day of class and thereafter	None

Meal Plans: Students may withdraw from the meal plans at any time by application to the Department of Food Services. Charges for meal plans will be refunded according to the above refund schedule.

Identification Card Fee: After the card is issued, none of this fee can be refunded.

Bus Pass: Bus charges are refundable according to the above refund schedule.

Yearbook: Yearbook charges are refundable in full during the semester in which payment is made. Thereafter, no refunds will be made on cancelled orders. Yearbooks must be picked up during the academic year in which they are published.

Students who will not be on campus when the yearbooks are published, usually by September 1, must pay a mailing and handling fee. Yearbooks will not be held, nor will they be mailed, without payment of the mailing and handling fee.

Refunds will not be made on books not picked up within one semester of the publication date.

Refunds will not be made before 21 days from the date of payment.

Refund policies contained herein reflect policies in effect at the time of publication and are subject to change.

DROP/ADD REFUNDS

A student may drop courses during the first 12 class days of a fall or spring semester and during the first 4 class days of a summer term or a 10-week summer semester. A student may add courses during the first 5 class days of a fall or spring semester and during the first 3 days of a 5-week summer term or a 10-week summer semester. Full refunds or supplemental billings will be made for courses dropped or added during these times. Refunds will be mailed to the student's local address. NOTE: Refunds will **not** be made for courses dropped during the Q-drop period.

Students are not allowed to drop all of their courses through the drop/add process. Once they have registered and paid fees, students must go through the withdrawal process in order to drop all courses and withdraw from the University.

REDUCTIONS

No reduction will be made in the charge for board in case of entrance within 10 days after the opening of a semester or summer term, nor will a refund be made in case of withdrawal during the last 10 days of a semester or summer term, or the last days for which payment is made.

UNPAID CHECKS

If a check accepted by the University is returned unpaid by the bank on which it is drawn, the person presenting it will be required to pay a penalty of $15. If the check and penalty are not cleared within 15 days from the date of the first notice, the student may be dropped from the rolls of the University. In addition, the check will be turned over to the county attorney for prosecution. Students dropped from the rolls of the University for failure to redeem an unpaid check or checks within the prescribed grace period are eligible for reinstatement only upon redemption of such check or checks, plus penalties, and the payment of a reinstatement fee of $50. If a tuition and fee check is returned unpaid, the time allowed to clear the check will be specified in the return check notice. Failure to clear returned fee checks by the due date given will result in cancellation of the student's registration.

CASH NEEDS

It is recommended that students have a checking account to meet cash and other financial needs while attending the University. MPACT and PULSE automatic teller machines are located near the east entrance to the MSC, and personal checks for up to $50 may be cashed at the main desk of the MSC.

UNIVERSITY-OWNED APARTMENTS

University-owned apartments, both furnished and unfurnished, are available to married students and their families; also, these apartments are available to unmarried graduate students (maximum of two students per apartment). Rental rates range from $170 to $268 per month. Utilities, with the exception of electric power, are paid for by the University. Applications for a University-owned apartment should be made one year in advance to the University-Owned Apartments Office, College Station, Texas 77843-3365 409/845-2264.

OFF CAMPUS HOUSING

Off campus students are served by the Off Campus Center, which keeps up-to-date information on apartment listings, rooms for rent, maps, shuttlebus and other information pertinent to the off campus student. A roommate referral service is available to help students find a person with whom to live. The center also operates a roommate referral service specifically for graduate students. The *Off Campus Living Survival Manual* is updated each spring to introduce students to the community and covers such topics as leases, transportation, security deposits, cost estimates and food arrangements. The Off Campus Center also works with students who are experiencing problems with their roommates or landlords. For information, write Off Campus Center, Department of Student Affairs, Texas A&M University, College Station, Texas 77843-1257 409/845-1741.

OFF CAMPUS AGGIES

The Off Campus Aggies (OCA) is a student organization whose officers are elected by off campus students. OCA officers and representatives aim to provide a voice for all off campus students, and they strive to improve facilities and services both at the University and in the community. OCA's services include: planning apartment socials, organizing apartment intramural teams and serving as an immediate resource to off campus students.

THE DEGREE OF MASTER OF SCIENCE

Residence (See also section entitled "Residence Requirements")

In partial fulfillment of the residence requirement for the degree of Master of Science, the student must complete, on the campus at College Station, 9 credit hours during one regular semester or one 10-week summer semester. Upon recommendation of the student's Advisory Committee with approval of the Office of Graduate Studies, a student may be granted exemption from this requirement. However, such a petition must be approved prior to the student's registration for the final nine credit hours of required course work.

Full-time staff members of the University or of closely affiliated organizations stationed at the main campus may fulfill total residence requirements by completion of less-than-full course loads. Specific authorization for such programs must be granted in advance by the employing agency. See also section entitled "Registration."

Student's Advisory Committee

After receiving admission to Graduate Studies and enrolling for course work, the student will consult with the head of his or her major or administrative department concerning appointment of the chair of his or her Advisory Committee. The student's Advisory Committee for the master's degree will consist of **not fewer than three members of the graduate faculty** representative of the student's fields of study and research; **one of the members must be from a department other than the student's major department.**

The chair, in consultation with the student, will select the remainder of the Advisory Committee. The chair will then notify the tentative members of the Advisory Committee, giving the student's name and field of study, and request that they consider serving on this Committee. The student will interview each prospective committee member to determine whether he or she is willing to serve. No individual located away

from the campus at College Station may serve as chair of a student's Advisory Committee but may serve as co-chair with an individual located at College Station.

If the chair of the student's Advisory Committee is unavailable for an extended time in any academic period during which the student is involved in activities relating to an internship, thesis, dissertation, or record of study and is registered for 684, 691, or 692 courses, the student may request, in writing, that the department head appoint an alternate Advisory Committee chair during the interim period.

The committee members' signatures on the degree plan indicate their willingness to accept the responsibility for guiding and directing the entire academic program of the student and for initiating all academic actions concerning the student. Although individual committee members may be replaced by petition for valid reasons, a committee cannot resign *en masse*. The chair of the committee, who usually has immediate supervision of the student's research and thesis, has the responsibility for calling required meetings of the committee, and for calling meetings at any other time considered desirable. The duties of the committee include responsibility for the proposed degree plan, the research proposal, the thesis, and the final examination. In addition, the committee as a group and as individual members is responsible for counseling the student on academic matters, and, in the case of academic deficiency, initiating recommendations to the Office of Graduate Studies.

Degree Plan

The student's Advisory Committee, in consultation with the student, will develop the proposed degree plan. **It should be completed, filed and approved by the Office of Graduate Studies no later than ninety (90) days prior to the final oral examination or thesis defense.**

This proposed degree plan must be submitted on the official form (available in the Office of Graduate Studies) with endorsements by the student's Advisory Committee and the head of the student's major department.

Students submitting proposed degree plans for Master of Science degrees should designate at the top of the official degree plan form, immediately following the degree designation (line 4), the program option desired (i.e., "Thesis option," or "Non-thesis option").

Additional course work may be added to the approved degree plan by petition if it is deemed necessary by the Advisory Committee to correct deficiencies in the student's academic preparation.

Credit Requirement

A minimum of 32 semester credit hours of approved courses and research is required for the thesis option Master of Science degree.

Ordinarily the student will devote the major portion of his or her time to work in one or two closely related fields. Other work will be in supporting fields of interest.

Limitations on the Use of Transfer, Extension and Certain Other Courses

If otherwise acceptable, certain courses may be used toward meeting credit-hour requirements for the master's degree under the following limitations:

1. a. A maximum of six credit hours of transfer course work with grades of B or better taken in residence at an accredited institution will be considered for transfer credit. Extension courses taken at institutions other than those within The Texas A&M University System are not acceptable for transfer credit.
   b. A maximum of 12 credit hours of course work taken by extension, including 685 (Problems) taken while not in residence on the main campus of Texas A&M University. Credit for course work taken by extension will be granted only for courses taken under the direction of Texas A&M University.

c. A maximum of 12 credit hours of 489 and/or 689 (Special Topics).
d. A total of 12 credit hours of **any combination** of a, b, and c above.

2. A maximum of eight hours each of 691 (Research), or 485 and/or 685 (Problems), and up to three hours of 690 (Theory of Research) or 695 (Frontiers in Research) — no more than 12 hours of any combination of these.
3. A maximum of two hours of Seminar (681).
4. A maximum of nine hours of advanced undergraduate courses (300 or 400 level).
5. No credit may be obtained by correspondence study.
6. For graduate courses of three weeks' duration or less, up to one hour of credit may be obtained for each five day week of course work. Each week of course work must include at least 15 contact hours.
7. No credit hours of 684 (Professional Internship) may be used for the degree of Master of Science thesis option.
8. A maximum of 12 credit hours of selected courses offered by the College of Medicine (900 level). For a listing of these courses, the student should see the head of his or her major department, the Dean of the College of Medicine, or the Office of Graduate Studies.

Exceptions will be permitted only in unusual cases and when petitioned by the student's Advisory Committee and approved by the Office of Graduate Studies.

Transfer of Credit

A student who has earned 12 hours of graduate credit in residence at Texas A&M University may be authorized to transfer more than six hours of specified courses from another institution upon the advice of the Advisory Committee and with the advance approval of the Office of Graduate Studies **if these courses are not available at Texas A&M University.** Otherwise the limitations stated in the preceding section apply. Course work taken at colleges and universities of foreign countries is normally not accepted for transfer credit. Course work **in which no formal grades are given or in which grades other than letter grades (A, B, C, etc.) are given (for example, CR, P, S, U, H, etc.) is not accepted for transfer credit.** Credit for course work submitted for transfer from any college or university must be shown in semester credit hours or equated to semester credit hours. An official transcript from the university in which the transfer course work was taken must be sent directly to the Office of Admissions and Records.

Foreign Languages

There is no specific language requirement for the Master of Science degree.

Thesis Proposal

For the thesis option Master of Science degree, the student must prepare a thesis proposal for approval by the Advisory Committee and the head of the major department. This proposal must be submitted in quadruplicate to the Office of Graduate Studies at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive the degree.

Thesis Option

An acceptable thesis is required for the Master of Science degree. The thesis must be the original work of the candidate and must be grammatically correct, reflecting the ability of the candidate to express thoughts clearly. In general, the format should be consistent with that used in scholarly journals in the candidate's field. Format instructions are available in the "Thesis Manual," which may be purchased at the University Bookstore. An abstract not exceeding 350 words and a vita page are included in the thesis.

Three copies of the thesis in its final form must be filed with the thesis/dissertation clerk of the Office of Graduate Studies (University Library) after approval by the student's Advisory Committee and the head of the student's major department. Deadline dates for filing are announced each semester or summer session in the "Office of Graduate Studies Calendar" (See Time Limit statement below).

A receipt issued by the Fiscal Department showing payment of the required thesis binding fee and the required collating and editing fee must be presented to the thesis/dissertation clerk before the thesis can be accepted.

Time Limit

All degree requirements must be completed within a period of seven consecutive years in order for the degree to be granted. Graduate credit for course work which is more than seven calendar years old at the time of the final examination (oral or written) may not be used to satisfy degree requirements.

Students who have chosen the thesis option must have the final corrected copies of the thesis accepted by the Thesis Clerk no later than one year after the final examination or within the seven year time limit, whichever occurs first. Failure to do so will result in the degree not being awarded.

Application for Degree

Formal application for the degree must be filed in the Office of Graduate Studies no later than 90 days prior to the end of the semester, or 30 days prior to the end of the summer term in which the student expects to complete his or her requirements for graduation.

Final Examination

The candidate must pass a final examination by dates announced each semester or summer session in the "Office of Graduate Studies Calendar." To be eligible to take the final examination, a student's GPR must be **at least 3.0; there must be no unabsolved grades of D, F, or U for any course listed on the degree plan.** To absolve a deficient grade, the student must have repeated the course and have achieved a grade of C or better. The announcement of the final examination should be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date for the examination. All course work on the degree plan must have been completed with the exception of those hours for which the student is registered. A thesis proposal must be on file in the Office of Graduate Studies.

The final examination covers the thesis and all work taken on the degree plan and at the option of the committee may be written or oral or both. The final examination is not to be administered until such time that the thesis is available to all members of the student's Advisory Committee in substantially final form and all members have had adequate time to review the document. The examination is conducted by the student's Advisory Committee as finally constituted. Persons other than members of the Graduate Faculty may, with mutual consent of the candidate and the major professor, attend final examinations for advanced degrees. Upon completion of the questioning of the candidate, all visitors must excuse themselves from the proceedings.

Thesis option candidates may petition to be exempt from their final examination provided their GPR is 3.5 or better and they have the approval of the Advisory Committee, the head of the student's major department, and the Office of Graduate Studies.

A student shall be given only one opportunity to repeat the final examination for the master's degree and that shall be within a time period that does not extend beyond the end of the next regular semester (summer terms are excluded).

Unless otherwise authorized by the Office of Graduate Studies, the final examination for the master's degree must be administered on the campus in College Station.

Non-Thesis Option

In some departments of the University requirements for the Master of Science degree may be satisfied by completing a minimum of 36 semester hours, of which 18 semester hours must be in the major department, and a minimum of six semester hours in supporting fields.

A thesis is not required. A final comprehensive examination is required and **no exemptions are allowed.** The requirements as to level of courses and examinations are the same as for the thesis option Master of Science degree.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Students pursuing the non-thesis option are not allowed to enroll in 691 (Research) for any reason and 691 may not be used for credit toward a non-thesis option Master of Science degree. A maximum of four credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), and up to three credit hours of 690 (Theory of Research) or 695 (Frontiers in Research) may be used toward the non-thesis option Master of Science degree. In addition, any combination of 684, 685, 690, and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan. All requirements for the non-thesis option Master of Science degree other than those specified above are the same as for the thesis option degree.

THE DEGREE OF MASTER OF AGRICULTURE

The Master of Agriculture (M.Agr.) degree is designed for students who want professional graduate training with a management orientation in agriculture, food and natural resources. It is intended to emphasize the problem solving skills involved in the use of science and technology to benefit humanity, not as a research degree.

Individuals with a baccalaureate degree from a college or university of recognized standing, or qualified Texas A&M University seniors during their last semester, may apply for admission to Graduate Studies to pursue the non-thesis degree of Master of Agriculture. The candidate's Advisory Committee shall specify prerequisite work where necessary.

The degree may be earned in any academic department of the College of Agriculture and in five interdisciplinary areas: agricultural chemistry, food science and technology, natural resource development, plant sciences and agricultural development.

A minimum of 36 hours is required for the Master of Agriculture degree. Approximately 12 credit hours are to be taken outside of the student's degree option. Students must complete 12 credit hours on the campus at College Station to satisfy the residence requirement.

No more than eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), no more than three credit hours of 690 (Theory of Research), nor any combination of 684, 685, and 690 totaling in excess of 25% of the total credit hour requirement shown on the individual degree plan, may be used toward the degree of Master of Agriculture.

The student must demonstrate problem solving capabilities. Degree candidates may gain such capabilities by completing a professional internship that is designed to provide meaningful, applied, practical experiences, and which will vary in duration from three to nine months depending upon departmental requirements.

A professional paper, which is a scholarly report of a problem solving nature, will be prepared by each student. The professional paper must be submitted to the student's Advisory Committee for approval prior to the final examination.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Master of Agriculture degree candidates do not qualify to petition for an exemption from their final examination.

THE DEGREE OF MASTER OF ARCHITECTURE

The Department of Architecture in the College of Architecture and Environmental Design offers programs of graduate study as preparation for professional careers in architecture, the construction industry and related environmental design fields. The Master of Architecture is a non-thesis degree and requires the completion of a minimum of 52 hours of course work and a satisfactory comprehensive final examination. For holders of five-year professional degrees in architecture, the minimum number of hours of required course work is 36, none of which may consist of 684 (Professional Internship). Holders of the Bachelor of Environmental Design (B.E.D.) degree from Texas A&M University and holders of five-year professional degrees in architecture will enter the program directly, subject to admission approval by the department and the Office of Graduate Studies. Holders of other baccalaureate degrees will normally be required to complete prerequisite course work in the Department of Environmental Design to attain B.E.D. equivalency.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

No more than eight credit hours each of 684 (Professional Internship), 685 (Problems), or 693 (Professional Study), nor more than three credit hours each of 690 (Theory of Research) may be used toward the degree of Master of Architecture—nor any combination of 684, 685, 690 and 693 totaling in excess of 16 credit hours of these courses in the 52-hour master's degree program or 11 credit hours of these courses in the 36-hour master's degree program.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.** Departmental requirements and regulations relating to degree plans, professional internships, etc., may be found in the departmental brochure. Students will not normally be permitted to undertake 684 (Professional Internship) as the final course in the sequence of study leading to the master's degree.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Candidates for the degree of Master of Architecture are not eligible for exemption from the final examination as outlined for the degree of Master of Science, non-thesis.

Except as noted above, the requirements for the degree of Master of Architecture are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF ARTS

Thesis Option

The degree of Master of Arts currently is offered to students majoring in anthropology, English, history, modern languages, philosophy or political science. The residence requirements for this degree are exactly the same as for the Master of Science degree, as is the requirement of a thesis, which must be the original work of the candidate. The thesis is expected to be a competently phrased narrative of the student's original research topic. Of the minimum of 30 semester hours required for the Master of Arts degree, **no more than six credit hours for thesis research (691)** may be counted toward the degree. The proposed degree plan for students seeking the M.A. must include study in more than one area of specialization, but these areas may be contained within the course offerings of a single department.

No credit hours of 684 (Professional Internship) may be used for the degree of Master of Arts. Except as noted above, the requirements for the degree of Master of Arts thesis option are identical with those for the Master of Science thesis option.

Foreign Languages: For the degree of Master of Arts a reading knowledge (usually represented by two years of college study) of at least one foreign language is normally required.

Students submitting degree plans for Master of Arts degrees should designate at the top of the official degree plan form, immediately following the degree designation (line 4), the program option desired (i.e., "thesis option," or "non-thesis option").

Non-Thesis Option

In departments of the University which are authorized to offer Master of Arts degrees, the requirements for the degree may be satisfied by completing a minimum of 36 semester hours, of which 18 semester hours must be in the major department, and a minimum of six semester hours in supporting fields.

A thesis is not required. A final comprehensive examination is required. The requirements as to level of courses and examinations are the same as for the thesis option Master of Arts degree.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Students pursuing the non-thesis option are not allowed to enroll in 691 (Research) for any reason and 691 may not be used for credit toward a non-thesis option Master of Arts degree. All requirements for the non-thesis option Master of Arts degree other than those specified above are the same as for the thesis option degree.

THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION

The College of Business Administration offers a graduate program leading to the degree of Master of Business Administration (M.B.A.). Enrollment in M.B.A. core classes is restricted to students in classifications 7 and 8 only. Classification 6 students are not eligible to enroll in M.B.A. core courses.

The M.B.A. degree consists of 57 semester credit hours of course work. Twelve hours of electives and 45 hours of M.B.A. core courses comprise the M.B.A. degree program. Prerequisite courses for the M.B.A. program include macroeconomics, microeconomics and calculus. The M.B.A. degree is a non-thesis degree for which a final oral examination is not required. Students admitted after Fall, 1987 may be eligible to reduce the number of required hours to a minimum of 36 hours by approved course waivers. Details concerning the M.B.A. curriculum and the waiver process may be obtained by contacting the Masters Programs Office, College of Business Administration. New students are admitted in both fall and spring semesters. The College of Business Administration is accredited by the American Assembly of Collegiate Schools of Business (AACSB) at both the baccalaureate and master's degree levels.

To satisfy the residence requirements, the student must complete 12 semester credit hours on the campus at College Station.

No more than eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), nor more than three credit hours each of 690 (Theory of Research) or 695 (Frontiers in Research) may be used toward the degree of Master of Business Administration; neither can any combination of 684, 685, 690 and 695 total more that 25 percent of the total credit hour requirement shown on an individual's degree plan.

In order to maintain good academic standing, an M.B.A. student must maintain a minimum cumulative 3.00 GPR each semester. If a student fails to attain a cumulative 3.00 GPR, he or she is placed on academic probation. Students on academic probation must raise their cumulative GPR to 3.00 or above by the end of the next nine hours of course work or within one calendar year, whichever comes first. If this requirement is not met, the M.B.A. Program Director will recommend that the Office of Graduate Studies block the student from further enrollment. If a student is blocked from further enrollment in the M.B.A. program, he or she shall not be permitted to enroll in other M.B.A. courses.

M.B.A. students must attain a minimum cumulative 3.00 GPR in M.B.A. core courses taken at the University. In addition, M.B.A. students must attain a minimum 3.00 cumulative GPR in all courses listed on their degree plans in order to graduate.

Except as noted above, the requirements for the degree of Master of Business Administration are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF COMPUTER SCIENCE

The degree of Master of Computer Science is a non-thesis degree, designed to complement the Master of Science degree in computer science. The degree requires the completion of a minimum of 36 hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

A maximum of eight credit hours each of 684 (Professional Internship), or 685 (Problems), three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Computer Science. Any combination of 684, 685, 690 and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

The candidate is not eligible to petition for an exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination must be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Except as noted above, the requirements for the degree of Master of Computer Science are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF EDUCATION

Graduate students majoring in adult and extension education, agricultural education, educational administration, educational curriculum and instruction, educational psychology, educational technology, health education, industrial education, physical education or vocational education may become candidates for the degree of Master of Education. This is a non-thesis degree which requires a minimum of 36 hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

A maximum of eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), up to three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Education. Any combination of 684, 685, 690 and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

The candidate is not eligible to petition for an exemption from the final examir tion as outlined for the degree of Master of Science. The announcement for the f examination must be submitted to the Office of Graduate Studies at least two wee advance of the scheduled date.

No examination may be held prior to the mid-point of the semester or sum term in which a student will complete all remaining courses on the degree plan.

Except as noted above, the requirements for the degree of Master of Educat are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF ENGINEERING

A student holding a Bachelor of Science degree in engineering or a qualified senior during the last semester may apply for admission to Graduate Studies to work toward the non-thesis degree of Master of Engineering, majoring in his or her particular field of engineering. Approximately one-third of the required 36 credit hours of course work will be taken in fields outside of the major field.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

The work in the major field will include one or two written reports (not necessarily involving results of research conducted by the candidate).

A maximum of eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), up to three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Engineering. Any combination of 684, 685, 690 and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

The candidate is not eligible to petition for an exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination must be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Except as noted above, the requirements for the degree of Master of Engineering are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF LANDSCAPE ARCHITECTURE

The College of Architecture and Environmental Design offers a non-thesis program leading to the degree of Master of Landscape Architecture. The degree requires the completion of a minimum of 40 hours of course work and a satisfactory comprehensive final examination.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

A maximum of eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), up to three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Landscape Architecture. Any combination of 684, 685, and 693 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

The announcement for the final examination must be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date. The candidate does not qualify to petition for an exemption from the final examination as outlined for the degree of Master of Science.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree plan.

Except as noted above, the requirements for the degree of Master of Landscape Architecture are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF PUBLIC ADMINISTRATION

Through its Department of Political Science, the College of Liberal Arts offers an interdisciplinary, non-thesis program leading to the degree of Master of Public Administration. This program of study is under the joint auspices of the College of Liberal Arts and the College of Business Administration, with the cooperation of the College of Engineering, and uses appropriate educational offerings throughout the University.

The minimum requirements for this degree are the completion of 36 hours of course work and a satisfactory final examination. To satisfy the residence requirement, the student must complete 12 credit hours on the campus at College Station.

This professional curriculum is primarily designed to provide broad preparation in public policy and administration for managerial careers in government services, which now comprise nearly one out of five of the employed civilian labor force. In addition, students may avail themselves of traditional University strengths in a wide range of supporting areas and departments in order to prepare themselves for careers in city management; in staff services such as personnel, finance or public relations; or in important governmental or industrial areas of policy and administration such as marine resources, energy, science and technology, agriculture and natural resources, judicial and regulatory processes, and defense and foreign affairs, among others.

Most holders of a bachelor's degree in one of the social sciences, or managerial sciences such as business administration, will normally be prepared to go directly into graduate courses leading to the M.P.A. degree. Others may be required to take preprofessional courses to fulfill prerequisites. For those with no prior administrative experience, an internship may be required.

A maximum of eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), up to three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Public Administration. Any combination of 684, 685, 690 and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

The candidate is not eligible to petition for an exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination must be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date.

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree program.

Except as noted above, the requirements for the degree of Master of Public Administration are identical with those for the degree of Master of Science.

THE DEGREE OF MASTER OF URBAN PLANNING

Students holding the baccalaureate degree may become candidates for the degree of Master of Urban Planning. This two-year interdisciplinary program provides opportunities for individual and collaborative work including the optional thesis. The minimum requirements for this degree are the completion of 48 hours of course work and a satisfactory final examination.

To satisfy the residence requirement the student must complete 12 credit hours on the campus at College Station.

A maximum of eight credit hours of 684 (Professional Internship), eight credit hours of 685 (Problems), up to three credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Urban Planning — nor any combination of 684, 685, 690 and 695 may not exceed 25% of the total credit hour requirement shown on the individual degree plan.

Only those candidates selecting the thesis option may qualify for exemption from the final examination as outlined for the degree of Master of Science. The announcement for the final examination in either case must be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date.

Students who undertake a professional internship in partial fulfillment of master's degree requirements after completing all course requirements for the master's degree **must return to the campus for the final examination.** The final examination **is not to be administered until all other requirements for the degree, including any internship, have been substantially completed.**

No examination may be held prior to the mid-point of the semester or summer term in which a student will complete all remaining courses on the degree program.

Except as noted above, the requirements for the degree of Master of Urban Planning are identical with those for the degree of Master of Science.

SUMMARY OF THE MAJOR STEPS REQUIRED BY THE OFFICE OF GRADUATE STUDIES IN FULFILLING REQUIREMENTS FOR THE MASTER'S DEGREE

OGS — Office of Graduate Studies
A&R — Admissions and Records
DH — Department Head
GA — Graduate Advisor
AC — Advisory Committee

Procedure	Initiate Through / Approved By	Time
1. Apply for admission	A&R / DH & OGS	At least 6 weeks prior to registration (7-8 months prior to registration for foreign students; use International Student Application)
2. Become familiar with general regulations and appropriate master's degree section of *Catalog*		Before registration
3. Meet with graduate advisor assigned by department head to plan course of study for first semester	DH & GA / GA	Before first semester registration
4. Establish Advisory Committee; prepare proposed degree plan	GA & DH / AC, DH & OGS	90 days prior to final oral or thesis defense
5. If thesis is required, submit thesis proposal	AC / DH & OGS	14 weeks prior to graduation
6. Apply for degree	OGS	See deadline in "Office of Graduate Studies Calendar"
7. Check to be sure degree program and Advisory Committee are up to date and all course work is complete		Well before final examination. Follow regular procedures for changes (see *Catalog*)
8. Submit announcement of the final examination	AC OGS	By deadline date in "Office of Graduate Studies Calendar"
9. Submit 3 approved final copies of thesis	AC & DH / OGS	By deadline date in "Office of Graduate Studies Calendar"
10. File letter-of-intent to continue for doctorate, if the student so plans	DH / OGS & A&R	Immediately upon completion of all requirements for master's degree
11. Arrange for cap and gown		Texas A&M Bookstore

THE DEGREE OF DOCTOR OF PHILOSOPHY

Work leading to the degree of Doctor of Philosophy (Ph.D.) is designed to give the candidate a thorough and comprehensive knowledge of his or her professional field and training in methods of research. The final basis for granting the degree shall be the candidate's grasp of the subject matter of a broad field of study and a demonstrated ability to do independent research. In addition, the candidate must have acquired the ability to express thoughts clearly and forcefully in both oral and written languages. The degree is not granted solely for the completion of course work, residence and technical requirements, although these must be met.

Residence (see also section entitled "Residence Requirements")

Students who enter the doctoral degree programs with baccalaureate degrees must spend two academic years in resident study on the campus at College Station. Students who hold master's degrees when they enter doctoral degree programs must spend one academic year in resident study on the campus. In either case, one academic year beyond the first year of graduate study must be in continuous residence on the campus of Texas A&M University at College Station. One academic year may include two adjacent regular semesters or one regular semester and one adjacent 10-week summer session.

To satisfy the continuous residence requirement, the student must complete a minimum of nine credit hours per semester or 10-week summer session for the required period. Those students who enter doctoral degree programs with baccalaureate degrees may fulfill residence requirements in excess of one academic year (18 credit hours) on the campus at College Station by attendance during summer sessions or by completion of a less-than-full course load (in this context a full course load is considered nine credit hours per semester). Full-time staff members of the University or of closely affiliated organizations stationed at the campus may fulfill total residence requirements by the completion of less-than-full course loads. See also section entitled "Registration."

A minimum of 96 credit hours beyond the baccalaureate degree or 64 credit hours beyond the master's degree is normally required for the degree of Doctor of Philosophy.

Time Limit

All requirements for the degree must be completed within a period of ten consecutive calendar years for the degree to be granted. Graduate credit for course work more than ten calendar years old at the time of the final oral examination may not be used to satisfy degree requirements.

Final corrected copies of the dissertation or record of study must be accepted by the Thesis Clerk no later than one year after the final examination or within the ten year time limit, whichever occurs first. Failure to do so will result in the degree not being awarded.

Student's Advisory Committee

After receiving admission to Graduate Studies and enrolling, the student will consult with the head of his or her major or administrative department concerning appointment of the chair of the Advisory Committee. The student's Advisory Committee will consist of **not fewer than four members of the graduate faculty** representative of the student's several fields of study and research; **one of the members must be from a department other than the student's major department.** A Representative of the Graduate Council (GCR) will be appointed to the student's Advisory Committee by the Office of Graduate Studies at the time of approval of the degree plan.

The chair, in consultation with the student, will select the remainder of the Advisory Committee. No individual located away from the campus at College Station may serve as chair of a student's Advisory Committee but may serve as co-chair with an individual located on the campus.

The committee members' signatures on the degree plan indicate their willingness to accept the responsibility for guiding and directing the entire academic program of the student and for initiating all academic actions concerning the student. Although individual committee members may be replaced by petition for valid reasons, a committee cannot resign *en masse*. The chair of the committee, who usually has immediate supervision of the student's research and dissertation or record of study, has the responsibility for calling all meetings of the committee. The duties of the committee include responsibility for the proposed degree plan, the research proposal, the preliminary examination, the dissertation or record of study, and the final examination. In addition, the committee as a group and as individual members is responsible for counseling the student on academic matters, and, in the case of academic deficiency, initiating recommendations to the Office of Graduate Studies.

Degree Plan

The Advisory Committee will evaluate the student's previous training and degree objectives. It will then outline a proposed degree plan and a research problem which, when completed, as indicated by the dissertation (or its equivalent for the degree of Doctor of Education, the degree of Doctor of Environmental Design, or the degree of Doctor of Engineering), will constitute the basic requirements for the degree. **The student's proposed degree plan must be filed with the Office of Graduate Studies no later than ninety (90) days prior to the preliminary examination.** The proposed degree plan will be submitted on standard forms, with endorsements by the student's Advisory Committee and the head of the major department, for the approval of the Office of Graduate Studies. A field of study may be chiefly in one department or in a combination of departments. All degree plans must carry a reasonable amount of 691 (Research).

Additional course work may be added by petition to the approved degree plan by the student's Advisory Committee if it is deemed necessary to correct deficiencies in the student's academic preparation.

Selected courses offered by the College of Medicine may be used for graduate credit. For a listing of these courses, the student should see the head of his or her major department, the Dean of the College of Medicine, or the Office of Graduate Studies.

No credit may be obtained by correspondence study or for any course of fewer than three weeks duration.

Transfer of Credit (See also page 36.)

Courses for which transfer credits are sought must have been completed with a grade of B or better and must be approved by the student's Advisory Committee and the Office of Graduate Studies. Credit for thesis or dissertation research or the equivalent is not transferable. Credit for "internship" course work in any form is not transferable. Credit for course work taken by extension at any college or university other than those in The Texas A&M University System is not transferable. Texas A&M University does not normally accept for transfer credit course work taken at colleges and universities of foreign countries. Course work **in which no formal grades are given or in which grades other than letter grades (A, B, C, etc.) are given** (for example, CR, P, S, U, H, etc.) is not accepted for transfer credit. Credit for course work submitted for transfer from any college or university must be shown in semester credit hours, or equated to semester credit hours. An official transcript from the university at which transfer courses are taken must be sent directly to the Office of Admissions and Records.

Languages

All students are required to possess a competent command of English. The doctoral (Ph.D.) foreign language requirement at Texas A&M University is a matter of departmental option, to be administered and monitored by the individual departments of academic instruction.

Examinations

The student's major department and his or her Advisory Committee may require qualifying, cumulative or other types of examinations at any time deemed desirable. These examinations are entirely at the discretion of the department and the student's Advisory Committee.

The preliminary examination is required. No student may be given a preliminary examination unless his or her current official GPR is at least 3.0. This policy applies to any written or oral portions. The preliminary examination for doctoral students shall be given no later than the end of the first semester after completion of formal course work and no earlier than a date at which the student is within approximately six credit hours of completion of the formal course work on the degree plan (i.e., all course work on the degree plan except 681, 684, 690, 691 and 692 courses). The examination shall be both oral and written unless otherwise recommended by the student's Advisory Committee (including the Graduate Council Representative) and approved by the Office of Graduate Studies. The written part of the examination will cover all fields of study included in the student's plan. Each member of the Advisory Committee will be responsible for administering a written examination in his or her particular field, **unless he or she chooses to waive participation in this part of the examination and so indicates on the announcement of the examination.** Two or more members of the Advisory Committee may give a joint written examination. One or more members may require a student to take a departmental examination to supplement or replace a written examination. Each written examination must be completed and reported as satisfactory to the chair of the Advisory Committee before the oral portion of the examination may be held. In case any written examination is reported unsatisfactory, the entire Advisory Committee must agree (1) to proceed with the oral portion of the preliminary examination, or (2) to adopt another course of action regarding the unsatisfactory written examination. Either procedure is subject to the approval of the Office of Graduate Studies.

The schedule for the preliminary examination must be approved by the Office of Graduate Studies. Formal announcement of the preliminary examination must be received in the Office of Graduate Studies no less than one week prior to the date of the first scheduled written examination. If departmental preliminary examinations are to be used as part of the written portion of the preliminary examination, the Office of Graduate Studies should receive prior notification of such examinations, along with a list of those students who are to participate, no less than one week prior to the date of the first (or only) departmental examination. Both the oral and the written portions of the preliminary examination must be administered on the campus in College Station.

Credit for the preliminary examination is not transferable. Both parts (written and oral) of the preliminary examination must be completed within a length of time approved by the Office of Graduate Studies, usually not to exceed two weeks. If a departmental examination is used as a part of the written portion of the preliminary examination, it must be the last departmental examination offered prior to the date scheduled for the preliminary examination. In the schedule of **the written portion, all members of the student's Advisory Committee are to be included.** The representative of the Graduate Council (GCR) is a member of the student's Advisory Committee, and is to be consulted in establishing examination dates and included among those who receive copies of the announcement of the examination schedule.

Through the preliminary examination, the student's Advisory Committee should satisfy itself that the student has demonstrated the following qualifications:

a. A mastery of the subject matter of all fields in the program.
b. An adequate knowledge of the literature in these fields and has powers of bibliographical criticism.

In case a student is required by his or her Advisory Committee to take, as a part of the written portion of a preliminary examination, an examination administered by a department, the department must:

a. Offer the examination at least once every six months. The departmental examination should be announced at least 30 days prior to the scheduled examination date.
b. Assume the responsibility for marking the examination satisfactory or unsatisfactory, or otherwise graded, and in the case of unsatisfactory, stating specifically the reasons for such a mark.
c. Forward the marked examination to the chairman of the student's Advisory Committee within one week after the examination.

The chair of the student's Advisory Committee is responsible for making all written examinations available to the members of the Advisory Committee at or before the oral portion of the examination.

The chair of the Advisory Committee will report in writing to the Office of Graduate Studies the results of the preliminary examination. The report should include recommendations regarding the student's admission to candidacy.

After passing the required preliminary oral and written examinations for the doctoral degree, the student must complete all remaining requirements for the degree within three calendar years. Otherwise, the student will be required to repeat the preliminary examination.

By permission of the student's Advisory Committee and the Office of Graduate Studies, a student who has failed the preliminary examination may be given one re-examination, only after a period of at least six months has elapsed.

A student must be registered in any semester or the first 5-week summer term in which he or she asks to appear for either the preliminary or the final examination.

Admission to Candidacy

To be admitted to candidacy for a doctoral degree, a student must have (1) passed the preliminary examination, (2) filed with the Office of Graduate Studies the approved dissertation proposal, and (3) completed all formal course work. The student must be admitted to candidacy well in advance of the date when the degree is to be granted. The final examination will not be authorized for any doctoral student who has not been admitted to candidacy.

Dissertation

The general field of research to be used for the dissertation should be agreed on by the student and the Advisory Committee at their first meeting, as a basis for selecting the proper courses to support the proposed research.

As soon thereafter as the research project can be outlined in reasonable detail, the dissertation research proposal should be completed. The research proposal should be approved at a meeting of the student's Advisory Committee, at which time the feasibility of the proposed research and the adequacy of available facilities should be reviewed. The approved proposal, signed by all members of the student's Advisory Committee, the Graduate Council Representative, and the head of the student's major department, should be submitted (in quadruplicate) to the Office of Graduate Studies for final approval.

The ability to perform independent research must be demonstrated by the dissertation, which must be the original work of the candidate. While acceptance of the dissertation is based primarily on its scholarly merit, it must also exhibit creditable literary workmanship. The format of the dissertation must be acceptable to the Office

of Graduate Studies. **Instructions as to format are available in the "Thesis Manual" which may be purchased at the University Bookstore.**

By dates announced each semester or summer session in the "Office of Graduate Studies Calendar," the candidate must submit to the office of the Thesis/Dissertation Clerk (University Library) three copies of the dissertation in final form. The dissertation must include all suggestions and corrections of the members of the student's Advisory Committee and must bear the signatures of the department head and the student's Advisory Committee, with the exception of the Graduate Council Representative.

An abstract not exceeding 350 words and a vita page are included in the dissertation. Two additional copies of the abstract and title page must be submitted with the dissertation for microfilming.

In addition to a dissertation binding fee, all successful candidates for the doctorate are required to pay to the Fiscal Department a dissertation microfilming fee. This fee is used to film doctoral dissertations in cooperation with University Microfilms. A receipt issued by the Fiscal Department showing payment of the required binding, collating and editing fee and the microfilming fee must be presented to the thesis/dissertation clerk before the dissertation or record of study can be accepted.

Application for Degree

Formal application for the degree must be filed in the Office of Graduate Studies no later than 90 days prior to the end of the semester, or 30 days prior to the end of the summer term in which the student expects to complete requirements for graduation. See Office of Graduate Studies Calendar.

Final Examination

The candidate for the doctoral degree must pass a final examination by deadline dates announced in the "Office of Graduate Studies Calendar" each semester or summer session. No student may be given a final examination unless his or her current official GPR **is 3.0 or better and he or she has been admitted to candidacy. There must be no unabsolved grades of D, F, or U for any course listed on the degree plan.** To absolve a deficient grade, a student must have repeated the course and have achieved a grade of C or better. A student must have completed all course work on his or her degree plan with the exception of any remaining 691 (Research) or 692 (Professional Study) hours for which he or she must be registered. The announcement of the final examination should be submitted to the Office of Graduate Studies at least two weeks in advance of the scheduled date. The student's Advisory Committee, as finally constituted, will conduct this examination. The final examination is not to be administered until such time that the dissertation or record of study is available in substantially final form to the student's Advisory Committee and the GCR and all concerned have had adequate time to review the document. While the final examination may cover the broad field of the candidate's training, it is presumed that the major portion of the time will be devoted to the dissertation and closely allied topics. Persons other than members of the Graduate Faculty may, with mutual consent of the candidate and the major professor, be invited to attend final examinations for advanced degrees. Upon completion of the questioning of the candidate, all visitors must excuse themselves from the proceedings. The Advisory Committee will submit its recommendations on the appropriate form to the Office of Graduate Studies regarding acceptability of the candidate for the doctoral degree. Students must be registered in the University in the semester or summer session in which the final examination is taken.

Students whose degree requirements include dissertations or records of study and who plan to graduate at the end of a summer session (i.e., in August) should always register during the first term of the summer session, even though degree requirements may make it necessary for them to register in the second term also.

The final examination for the doctoral degree must be administered on the campus in College Station.

THE DEGREE OF DOCTOR OF EDUCATION

The Doctor of Education (Ed.D.) degree is a professional degree designed to prepare candidates for positions of leadership in the full range of educational settings, including public and private schools and colleges, business, government, industry and the military establishment. The program is designed for the practitioner; graduates may be expected to fill instructional, supervisory and administrative positions in which educational services are to be rendered.

Although substantively different from the Ph.D. degree in education, the Ed.D. degree requires equivalent admission qualifications, standards of scholarship, and breadth and depth of study. Since graduates of the program are expected to demonstrate a high level of professional skill and educational statesmanship, only those candidates who show a consistently high level of professional performance in their academic studies, in their role-related studies, in their internship experience, and in the completion of their records of study will be recommended for the degree.

The Ed.D. degree is available in adult and extension education, educational administration, educational curriculum and instruction, educational psychology, health education, industrial education, physical education and vocational education. Details of the degree requirements are presented below.

Admission

Applicants must hold the master's degree, must have completed at least three years of professional experience in an educationally related setting, and must submit Graduate Record Examinations scores and an academic record acceptable to the department to which they apply. They must also complete a written instrument which assesses their knowledge of the requirements and duties of the professional roles to which they aspire and demonstrates their ability to write with clarity, organization and correctness.

Degree Plan

Each student's proposed degree plan will be individually designed on the basis of the student's career objectives and the competencies associated with the professional role to which the student aspires. It will contain a minimum of 64 semester hours, including the following components:

1. at least six semester hours of proseminars stressing the foundation concepts with which every Ed.D. student should be familiar;
2. a set of courses selected to prepare the candidate for a specific professional role within a field of specialization;
3. one or more courses that develop basic understanding of the procedures and applications of research;
4. at least one supporting field of 12 or more semester hours or two supporting fields of nine or more semester hours each;
5. a professional internship of at least six semester hours related to the professional role to which the student aspires;
6. a record of study (described below) involving at least 12 semester hours of credit.

Residence

The residence requirement for the Ed.D. degree is 30 semester hours taken on the campus at College Station, Texas. Of these 30 semester hours, at least 18 must be taken as a full time student. The residence requirement must be fulfilled within five consecutive calendar years. This requirement may be satisfied by a student who

presents any combination of full time study during summer sessions of at least 5-weeks duration and/or work as a full-time student during regular sessions which totals in the aggregate at least 18 semester hours, accomplished within a five-year period beginning with the first course proposed to apply to this requirement.

Internship

Each Ed.D. degree candidate will complete a university-directed internship in a professional employment setting with a minimum duration of 300 clock hours accrued at the rate of 10-40 hours per week. The internship will require of the student full participation and responsibility in experiences directly related to the student's career specialization. Credit for the internship will not be given for a continuation of regular employment activities (e.g., continuing to serve as a junior college teacher or as an elementary school principal), but only for completing an entirely new work experience. The internship may be on a paid or unpaid basis, must be undertaken after the student has a degree plan on file, and must be supported by prior or concurrent course work (usually toward the end of the degree program). Prior to its beginning, the internship must be approved in writing as to details by all members of the students' doctoral committee. At the conclusion of the internship, a formal written summary of its nature and results must be approved by the student's Advisory Committee.

Record of Study

The Ed.D. student will produce a major research document called a record of study. The research project may involve such topics as (1) a field study on a problem of major proportions in time or extent; (2) a curriculum development project validated through pilot and field testing; or (3) action research on a curricular, instructional, supervisory, or administrative problem based on empirical data. The Ed.D. student must have primary responsibility for the design and development of the research, and the record of study must be the sole and original work of the candidate.

Whatever the nature of the research project undertaken by the candidate, he or she will be required to prepare a record of study which explains and supports the activities undertaken in the project and supports its conclusions with adequate investigations, empirical data and a comprehensive bibliography. The record of study will follow the instructions available in the "Thesis Manual" which may be purchased at the University Bookstore. Procedures used in the student's research will be described in sufficient detail for educators in other locations to apply or extend the procedures. All records of study should be characterized by accuracy of observation and measurements, thoroughness of analysis and synthesis, and accuracy and completeness of presentation.

Examinations

Each Ed.D. degree candidate is required to take a departmentally-prepared written qualifying examination prior to the completion of 30 hours of doctoral work. Although not an absolute requirement, the student is encouraged to take the required six hours of proseminar before taking the qualifying examination. Continuation in the program and/or any additional required study is dependent on the results of this qualifying examination. The chair of the student's Advisory Committee will report in writing to the Office of Graduate Studies the results of the qualifying examination.

In addition, each candidate must successfully complete an oral and written preliminary examination prior to admission to candidacy and a final oral examination upon completion of the record of study. Both of these examinations will conform to the requirements for the Ph.D. preliminary examination and final examination as set forth in the *Graduate Catalog*.

Except as noted in the sections above, the requirements for the Doctor of Education degree are identical with those for the degree of Doctor of Philosophy.

THE DEGREE OF DOCTOR OF ENGINEERING

The Doctor of Engineering program has as its objective the education of men and women to function at the highest levels of the engineering profession, with emphasis on solving problems which arise in the use of technology to benefit mankind. Since these problems frequently have a societal impact which is non-technical in nature and since technological advances are implemented through business and industry, the Doctor of Engineering program seeks to couple understanding of the characteristics of social and business institutions with high competence in solving engineering problems.

The curriculum is nominally a 96 semester-credit-hour professional program beyond the baccalaureate degree. A minimum of 60 credit hours beyond the master's degree will be required. These totals include a maximum of 16 credit hours for a professional internship.

Following entry into the professional program, the student will complete a minimal 36 semester-credit-hour course of study prior to a one calendar year (4 credit hours per semester) internship in which the student will extend his or her education in a practice-oriented environment such as an industrial organization. The professional programs are administered by the departments of the College of Engineering, together with the College of Engineering and the Office of Graduate Studies.

The final oral/written examination for the Doctor of Engineering degree is administered by the student's Advisory Committee, as approved by the College of Engineering and the Office of Graduate Studies.

Additional information can be obtained from the Office of Graduate Studies, the College of Engineering, or any department in the College of Engineering.

Admission

Applicants possessing baccalaureate degrees and a 3.0 grade point ratio (GPR) or graduate degrees may seek admission, provided they meet or exceed academic requirements listed below. These students must be admitted to the program by both the Office of Graduate Studies and the College of Engineering.

To be admitted to the Doctor of Engineering program by the College of Engineering, applicants must complete the appropriate application form, provide transcripts of all academic work taken beyond the secondary school level, prepare a 300-word essay dealing with the applicants' motivations for seeking admission to the program, be recommended by their respective departments, be interviewed by the admissions sub-committee of the Doctor of Engineering Program Committee, and be approved by the College of Engineering.

Students seeking admission beyond the master's level are required to pass the oral and written examinations associated with the Doctor of Engineering qualifying examination described in "Examinations."

Admission to Graduate Studies does not imply admission to the Doctor of Engineering program, nor does admission to the program by the College of Engineering imply admission to Graduate Studies.

Residence

Students who enter the D.Eng. program with baccalaureate degrees must spend two academic years in resident study on the campus at College Station. Students who hold master's degrees when they enter the program must spend one academic year in resident study on the campus. In this context, an academic year is defined as two regular semesters, two 10-week summer semesters, or a regular semester and a 10-week summer semester. To satisfy the residence requirement, the student must complete a minimum of nine credit hours per semester or 10-week summer semester for the required period.

Student's Advisory Committee

After receiving admission to Graduate Studies and to the Doctor of Engineering program, the student will consult with the head of his or her administrative department concerning appointment of the chair of the Advisory Committee. The student's Advisory Committee will consist of not fewer than four members of the graduate faculty representative of the student's several fields of study. One member of the committee must be from a department other than the student's administrative department.

The student's internship supervisor, a practicing engineer, is also a member of the Advisory Committee.

The chair, in consultation with the student will select the remainder of the Advisory Committee. The chair will notify the tentative members of the Advisory Committee, giving the student's name and field of study, requesting that they consider serving on the Advisory Committee. The student will interview each prospective committee member to determine whether he or she will accept the assignment.

The student's Advisory Committee has the responsibility for guiding and directing the entire academic and internship programs of the student and for initiating all actions concerning the student. The chair of the Advisory Committee, who usually has immediate supervision of the student's program, has the responsibility for calling required meetings of the Advisory Committee and calling meetings at any other time considered desirable.

The duties of the Advisory Committee include responsibility for the proposed degree program, the Doctor of Engineering qualifying examination (written and oral), the technical adequacy of the internship program, the qualifications of the student to embark on the internship, the internship report, and the final examination. In addition, the Advisory Committee as a group and as individual members is responsible for counseling the student on academic matters, and, in the case of academic deficiency, initiating recommendations to the Dean of the College of Engineering and the Director of the Office of Graduate Studies.

Degree Plan

The student's Advisory Committee will evaluate the student's previous education and career objectives. The committee will then outline a proposed degree plan which will constitute the basic academic requirements for the degree. The student's proposed degree plan must be filed with and approved by the Office of Graduate Studies no later than ninety (90) days prior to the preliminary examination. It will be submitted on standard forms, with endorsements by the student's Advisory Committee and the head of the student's administrative department, for the approval of the Dean of the College of Engineering and the Office of Graduate Studies. At the time of approval, the Dean of Engineering will appoint a representative of the College of Engineering to the student's Advisory Committee and the Office of Graduate Studies will appoint a Graduate Council Representative (GCR) to the student's Advisory Committee.

The graduate portion of the proposed degree plan will include a minimum of 96 semester credit hours. Of these, 80 semester credit hours of course work are required; the Professional Internship (see section on "Internship") will earn 4 semester credit hours per semester and per summer term.

The 80 semester credit hours of graduate course work shall include a minimum of 20 semester credit hours of required core course work, 12 semester credit hours of elective professional development courses, 32 semester credit hours of department-oriented graduate level courses, 12 semester credit hours of engineering design courses, and 4 semester credit hours of professional development seminar.

Additional course work may be added by petition to the approved degree plan by the student's Advisory Committee if such additional course work is deemed necessary to correct deficiencies in the student's academic preparation.

Scholarship

In order to remain in good standing, students admitted to the Doctor of Engineering program must maintain a GPR of 3.25 during their graduate studies.

Examinations

All students admitted to the program are required to pass a comprehensive written and oral examination called the Doctor of Engineering Qualifying Examination. It will be administered when semester credit hours equivalent to the number required for a Master of Engineering degree have been accumulated. Individuals holding a master's degree when they enter the Doctor of Engineering program will be expected to take the Doctor of Engineering Qualifying Examination during their first semester of enrollment. The examination determines whether or not the student is prepared to continue study toward the Doctor of Engineering degree. A student who fails the Qualifying Examination may, with the approval of the Advisory Committee and the Office of Graduate Studies, retake the examination once. The second examination will be administered after a suitable period of preparation, normally not less than six (6) months, upon the recommendation of the Advisory Committee.

The student's major department and Advisory Committee may require departmental, cumulative, or other types of examinations at any time deemed desirable. These examinations are entirely at the discretion of the department and the student's Advisory Committee. For instance, these examinations may be used for determining the technical depth and breadth required for the internship project. The candidate for the degree of Doctor of Engineering must pass a final oral examination in the final semester of course work following the internship. This exam will include presentation of results of internship work. The student's Advisory Committee, as finally constituted, will conduct this examination, which will include the internship experience and closely allied topics as well as the broad field of the candidate's training. Persons other than members of the Graduate Faculty may, with mutual consent of the candidate and the major professor, attend final examinations for advanced degrees. Upon completion of the questioning of the candidate, all visitors must excuse themselves from the proceedings. The Advisory Committee will submit its recommendations through the Dean of Engineering to the Office of Graduate Studies regarding the acceptability of the candidate for the doctoral degree.

Internship

As part of the degree requirements, each student will spend a minimum of one calendar year working under the supervision of a practicing engineer in industry, business or government. The objectives of the internship are two-fold: (1) to enable the student to demonstrate the ability to apply both knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served, and (2) to enable the student to function in a non-academic environment in a position in which he or she will become aware of the organizational approach to problems, in addition to those of traditional engineering design or analysis. During the internship phase of the program, the student must be continually enrolled in the University.

The nature of the internship experience will be determined by mutual consent among the student, the Advisory Committee, and the supervising organization prior to commencement of the internship period. It is expected that the internship experience will be at a level in the organization which will enable the student to deal with broadly based problems affecting more than one facet of the organization, rather than a single narrow or specific technical problem. It is the student's responsibility to identify and arrange a suitable internship. Specific arrangements for the internship will be made through the student's major department, and an internship agreement must be negotiated between the student and the Advisory Committee, and the internship supervisor and appropriate representatives of the industrial organization. Copies of all

agreements must be approved by the College of Engineering and the Office of Graduate Studies.

Record of Study

A Record of Study, which usually is a report of the student's internship experiences, must be prepared in accordance with guidelines issued by the Doctor of Engineering Program Committee. By dates announced each semester, the candidate must submit to the Office of the Dean of Engineering three copies of the Record of Study in final form. The suggestions and corrections of the members of the Advisory Committee must be incorporated, and the report must bear the signature of the department head and the members of the student's Advisory Committee with the exception of the representative of the Graduate Council. The Record of Study must be the original work of the candidate. This Record of Study must also be approved by the Thesis Clerk as in the case of a Ph.D dissertation.

Except as noted in the sections above, the requirements for the Doctor of Engineering degree are identical with those for the degree of Doctor of Philosophy.

THE DEGREE OF DOCTOR OF ENVIRONMENTAL DESIGN

Work leading to the degree of Doctor of Environmental Design (D.E.D.) is intended to provide the candidate with a thorough and comprehensive knowledge of the profession of landscape architecture and training in methods of research.

Each student is expected to enter the program with mature objectives, a clear choice of a professional discipline and a strong interest in a specific aspect of the profession. The student will essentially be responsible, in consultation with his or her Advisory Committee, for developing a proposed degree plan.

Admission

In addition to the normal admission requirements of the Office of Graduate Studies, each applicant for admission to the D.E.D. program of the Department of Landscape Architecture must submit the following materials to the department:

A. An illustrated brochure, or portfolio, which has been designed to exhibit the individual's professional experience and competence. Preferred format size is 8½″ × 11″.
B. A paper stating the individual's understanding and philosophy regarding the ethic, societal value and scope of the profession of landscape architecture; and the individual's professional goals and objectives for pursuing his or her program of study.
C. A minimum of three letters of support addressing the candidate's ability to pursue doctoral work and to understand the profession of landscape architecture.

Program Requirements

Students entering the D.E.D. program must complete 96 hours of approved study beyond the baccalaureate degree or 56-64 hours beyond the master's degree. Core course work is required in data processing, technical writing, statistics, and research methods. A minimum of 6 credit hours must be taken outside the major field. A maximum of 24 credit hours will be allowed for a written dissertation, which must be the original work of the candidate on a subject approved by the candidate's Advisory Committee, the department, and the Office of Graduate Studies.

Except as noted above, the requirements for the degree of Doctor of Environmental Design are identical with those for the degree of Doctor of Philosophy.

SUMMARY OF THE MAJOR STEPS REQUIRED BY THE OFFICE OF GRADUATE STUDIES IN FULFILLING REQUIREMENTS FOR THE DOCTORAL DEGREE

DH—Department Head
GA—Graduate Advisor
AC—Advisory Committee
GCR—Graduate Council Representative
OGS—Office of Graduate Studies
A&R—Admissions and Records

Procedure	Initiate Through / Approved By	Time
1. Apply for admission	A&R / DH & OGS	At least 6 weeks prior to registration (7-8 months prior to registration for foreign students; use International Student Application)
2. Familiarize yourself with general regulations and appropriate doctoral degree section of *Catalog*		Before registration
3. Meet with graduate advisor assigned by department head to plan course of study for first semester	GA & DH / GA	Before first semester registration
4. Establish Advisory Committee; prepare degree plan	GA & DH / AC, DH & OGS	Ninety (90) days prior to preliminary examination
5. Complete course work detailed on proposed degree plan		Prior to preliminary examination (See *Catalog* for specific details)
6. Arrange preliminary examination	AC / OGS	
7. Submit proposal for dissertation or record of study	AC, DH & GCR / OGS	Well in advance of expected graduation date
8. Request ADCom to recommend admission to candidacy; completion of 5, 6, and 7 above required	AC / OGS	Well in advance of the date on which the degree is to be conferred
9. Prepare rough draft of dissertation	AC	
10. Apply for degree	OGS	During final semester; see "Office of Graduate Studies Calendar" for deadline
11. Submit announcement for final examination	AC / OGS	See "Office of Graduate Studies Calendar" for deadline
12. Submit 3 approved final copies of dissertation or record of study	AC & DH / OGS	See "Office of Graduate Studies Calendar" for deadline
13. Arrange for cap, gown, and hood		Texas A&M Bookstore

GRADUATION

Graduate degrees are conferred at the close of each regular semester and summer session. Candidates for advanced degrees who expect to complete their work at the end of a given semester must apply for graduation by submitting the appropriate forms to the Office of Graduate Studies and paying the required fee at the Fiscal Office no later than 90 days prior to the end of the semester or 30 days prior to the end of the summer term.

PUBLICATION OF THESIS OR DISSERTATION MATERIAL

Graduate students pursuing work leading to an advanced degree may publish in scholarly journals materials that may subsequently be used as a part of the thesis, dissertation, or record of study provided the Office of Graduate Studies is notified of this intention by the student at the time the paper is submitted for publication. The complete title, the names of authors as they appear on the paper, and the name of the journal must be furnished.

LIBRARY FACILITIES

Sterling C. Evans Library

The University's principal research collections, numbering over 1,700,000 volumes and 3,300,000 microforms are housed in a centrally located facility providing seating for 4,470 readers.

On the third through sixth floors 572 lockers are available for assignment to graduate students. There are, in addition, 417 closed studies for use by faculty members and doctoral students engaged in research requiring extensive and constant use of library materials.

Centralized reference service is available on the first floor. The Documents Division, located on the second floor, offers assistance in using the large collection of government documents and technical reports.

More than 16,000 serial titles are received, as well as state, national and foreign newspapers. The library is also a depository for selected federal documents. The Technical Reports Department includes university, government and corporation reports. Its emphasis is on three major subject collections — oceanography and sea grant, transportation and water. It also houses over 700,000 reports (primarily, but not exclusively, in the engineering disciplines) on microfiche.

Most materials may be checked out for a period of four weeks. Exceptions are periodicals, which can be checked out for four hours, and reference materials and materials temporarily reserved by instructors for required reading which must be used in the library.

Another special service is offered in bibliographic instruction. Tours of the library can be arranged to cover areas from general orientation to in-depth bibliographic instruction in specific fields of study. Classroom instruction is also available. Contact the instructional services librarian for further information.

The library's Automated Information Retrieval Service (AIRS) offers a wide range of on-line and laser disk bibliographic and statistical data bases. All major fields of inquiry are represented in the data bases. Types of materials retrieved by the system range from technical reports and patent information to published articles and project

descriptions for current research activities. Costs vary with the data base searched. Students, faculty and staff can also access national and international bibliographic databases at a nominal cost through the "do-it-yourself" computerized searching service offered by the Reference Division.

A Learning Resources Department (LRD) located on the sixth floor has more than 150 microcomputers with several printers that are available to students for class and research-related use. Audio visual materials and equipment are also available in this department.

The Special Collections Division, housed on the second floor of the Evans Library, includes several collections which support research in specific subject areas. These are the Jeff Dykes Range Livestock Collection (including a sub-collection of J. Frank Dobie items), a Western Illustrators Collection, the Science Fiction Research Collection, a Somerset Maugham collection, the Texas Collection, the Ku Klux Klan Collection, the Dyksterhuis Collection of the Earliest Scientific Literature of the Forests and Ranges of North America, the Bodenstein Reprint Collection on Developmental Biology, and a collection of early architectural works. Additionally, there is a small collection of approximately 1,000 rare books on a wide variety of topics.

Medical Sciences Library

This special library, located across the street from the College of Veterinary Medicine and adjacent to the College of Medicine, serves the two colleges as well as all other students and faculty of Texas A&M University needing access to the biomedical collection. The library serves as the administrative component of a three-unit consortium of medical libraries for the College of Medicine. Resources are shared among the libraries by way of subminute telefacsimile transmission of hard copy.

The Medical Sciences Library's collection numbers approximately 100,000 volumes of bound journals and books, and the library currently subscribes to approximately 2,000 American and foreign periodicals.

Medical reference service is extended to students, faculty, and medical and veterinary practitioners in the region. These services provide information available in books and journals and from on-line data bases from the National Library of Medicine, Dialog, and BRS. The Medical Sciences Library currently provides on-line access to its public catalog through a computerized system, LS/2000 Local System, but will be changing to NOTIS sometime in 1990.

Books circulate for two weeks unless temporarily reserved for required reading. Periodicals do not circulate. Five copy machines operating with Vendacards or coins are available within the library. A copy service is also available.

COMPUTING SERVICES

Texas A&M University provides an extensive array of computing resources to support instructional, research and administrative computing. The Computing Services Center (CSC) is one of the finest and most sophisticated computing centers of any educational institution in the nation. The computing environment is supported by an IBM 3090-200E with one vector facility, an AMDAHL 5860, DEC VAX 8650, VAX 6220 and VAX 11/785 system connected with departmental machines to a form several hundred node Ethernet. Generally available resources include specialized facilities such as electronic printing systems, a graphics laboratory and campus computing networks. Specialized software is available to assist the student and researcher in many areas including the analysis of data and preparation of reports with supporting graphics. In addition, a highly talented staff is available to assist in providing computing support.

In addition to the global facilities, there are many "departmental" computing systems providing direct support to a particular group of users or to a special project. These systems include an IBM 4361, a VAX 8650 and 8800, thirty-five VAX including two with FPS array processors, ten PRIME and seven Data General systems. Other minicomputers available include AT&T, Harris, Hewlett-Packard, Pyramid and Symbolics. There are several hundred workstations on the campus network including DEC, SUN, Apollo and Hewlett-Packard.

Over 3,000 University-owned microcomputers used as "personal" tools assist Texas A&M researchers, students and administrators in meeting a broad range of computing requirements. These microcomputers are strategically located around the campus in general access facilities.

The IBM 3090-200E has 128 megabytes of memory and 32 channels; the AMDAHL 5860 has 32 megabytes of memory and 32 channels. The IBM 3090-200E operates with the MVS/XA/JES3 operating system. The 5860 runs the VM/CMS operating system and provides a UNIX(UTS) environment. Two data base management systems, ADABAS and IMS/DB, operate on the MVS system. Software includes statistical packages, SAS, SPSS, BMDP; optimization packages, MPSX, XMP, MINOS, simulation package GPSS; and a wide variety of application packages and language compilers.

There are 95 gigabytes of on-line disk storage available to the combined MVS and MV systems. Tape drive support is provided by nine tape units. One Xerox 4050 and two Xerox 9700 electronic printing systems provide high quality, high speed output for both printed and graphic material. An additional high speed printer and three medium speed printers augment the printing capacity.

Graphics support is provided by a variety of graphic output devices and software. Graphic devices available include 11 and 36 inch Versatec electrostatic plotters, a 36 inch Houston Instrument 4-pen color plotter, several graphics terminals and a high resolution Colorgraphic camera system. Software includes SAS/GRAPH; DISSPLA, TELL-A-GRAF, CUECHART and TELLAPLAN; NCR graphics; Versaplot and EPIC; and ICU (Interactive Chart Utility).

The DEC VAX 8650, VAX 6220 and 11/785 operate as a VAX cluster sharing 8 gigabytes of disk storage. The 8650 has 68 megabytes of memory with an 80 nanosecond cycle time. The 11/785 has 32 megabytes of memory with a cycle time of 135 nanoseconds. The operating system is VMS. The cluster is supported by two printers as well as by access to the Xerox 9700 printers. Software on the cluster includes a variety of language compilers, graphics and scientific subroutine libraries.

An extensive network provides access to the above systems as well as systems throughout the state, the United States and foreign countries. The network is comprised of two major parts: a campus wide Ethernet provides connections for the VAX systems. This network has 55 major nodes, over 120 terminals directly connected to the network and an SNA gateway to the IMB and AMDAHL systems. The SNA gateway allows terminals on DECNET to access the IBM and AMDAHL computers and vice versa. The DECNET is part of THENET, a network of over 100 nodes at Texas A&M University, University of Texas at Austin, the University of Houston and other Texas universities.

The second major network is composed of Micom asynchronous port selectors strategically located around campus. This network provides over 2500 "hard wired" connections as well as dial-up capability. The port selectors, operating at 9600 baud, provide access to the IBM and AMDAHL computers and the Ethernet.

Texas A&M University if part of SESQUINET, a high speed network which links several universities in Texas. The NEC SX-2 supercomputer at the Houston Area Research Consortium is part of this network and is a gateway to the Internet (ARPAnet). This network provides high speed access to other universities and research laboratories in the United States as well as to the National Science Foundation's supercomputer network.

BITNET is an international network which provides file transfer and electronic messaging among the systems on campus, across the nation and internationally.

DIVISION OF STUDENT SERVICES

The Division of Student Services is a cluster of administrative departments under the supervision of the Vice President for Student Services. It is designed to serve students at Texas A&M University and includes:

Recreational Sports at Texas A&M is generally recognized as one of the best all-around intramural and recreational sports programs in the country. Recreational Sports offers the Intramural Program, Sport Club Program, TAMU Outdoors Program and informal recreation. Intramurals provides an opportunity for students to participate in a wide variety of sports activities and also affords a splendid educational opportunity for the students who serve as intramural officials and supervisors. Intramurals attempts to provide each student with the opportunity to participate in activities as regularly as his or her time and interest permit. These activities are organized on an individual basis as well as in teams, thereby enabling all to participate.

The Sport Club Program offers students the opportunity to represent Texas A&M at local, regional and national competitions in thirty different sports. Each club supplies instruction to the novice athlete as well as highly competitive opportunities for the skilled athlete. TAMU Outdoors allows students access to equipment for outings and offers trips for students wishing to learn more about outdoor recreation. Through regular participation, it is hoped that the individual will develop an appreciation of the worthy use of leisure time and a wholesome attitude toward physical activity.

Recreational facilities such as weight rooms, racquetball/handball courts and basketball courts located in the Read Building, G. Rollie White Coliseum and DeWare Field House are available for daily use. Outdoor facilities include football, softball and soccer fields as well as a golf driving range located at the Intramural Sports Center and Penberthy Intramural Center.

Memorial Student Center is a combination of a beautiful facility and a wide variety of services and programs intended to meet the cultural, social and recreational needs of the university community. This facility includes meeting rooms, a printing center, the central ticket office, lounges, a cafeteria and snack bar, bookstore, a music listening room, bowling lanes and an art gallery. The MSC Council (located in room 216) is responsible for producing a wide variety of programs, ranging from ballet to backpacking, as well as for providing a laboratory for individual growth and development. OPAS, Town Hall, Aggie Cinema, Great Issues, Madrigal Dinners, Political Forum, and the Visual Arts Committee are examples of some of the 30 programming committees of the MSC Council. All students are invited to become involved in MSC programs and to use the facilities and services of the MSC.

Office of the Students' Attorney. The Office of the Students' Attorney is staffed by licensed attorneys who offer legal advice and counseling to all students and recognized student organizations. Some of the most common legal matters on which students request advice are landlord/tenant problems, consumer protection, auto accidents and the domestic relations law. Advice, however, is not restricted to these subjects, and students with any type of legal problems are encouraged to see the students' attorney.

The students' attorney is limited in matters of litigation and can only represent students in court in consumer protection cases. Additionally, the students' attorney cannot represent students against Texas A&M University nor against another student. Please call one week in advance for an appointment (409/845-5821, Room 359, Bizzell Hall).

Office of the Commandant plans, coordinates and implements programs of the Corps of Cadets. Army, Navy/Marine and Air Force ROTC programs are offered. Graduate students pursuing a commission through the ROTC program are authorized membership in the Corps of Cadets (409/845-2811, Room 102, Military Sciences Building).

Student Counseling Service (SCS) provides limited duration counseling on an appointment basis. Services provided include educational planning, career choice (including computer assisted career guidance), personal-social, marriage/couples, human sexuality, crisis/emergency and various types of group counseling; study skills training; the administration and interpretation of study skills, interest and personality inventories; an academic, educational, career, and personal growth information library; relaxation/biofeedback training; the Counseline self-help topical tape program (call 845-2958 to make anonymous requests); and referral to other specialized sources of help found within the University and the surrounding geographic area. Confidentiality, to the limits provided by law, is respected and no record of students' visits to the SCS is made on an academic transcript or in a job placement file. Except for certain special services, no fees are charged for any counseling services.

In a crisis/emergency situation, come to the Student Counseling Service weekdays from 8 a.m. to 5 p.m.; at night and on weekends, call the Student Health Center at 409/845-1557 or go to that facility (use the "Urgent Care" entrance). The SCS is located on the third floor, YMCA Building. Call 409/845-1651 for study skills, testing, academic and career counseling and 409/845-4427 for personal and weekday daytime emergency counseling.).

Student Activities assists approximately 550 student organizations, including the Graduate Student Council, with annual recognition, organizational development, funding, and activities. This office also coordinates leadership programs, minority student affairs, international student services and vocal music programs; publishes calendars, handbooks and other publications of an informational nature for the university community; and schedules Hensel Park and All Faiths Chapel facilities (409/845-1133, main office in Room 208, Pavilion).

Student Affairs is responsible for coordinating programs and activities in the following areas: On campus and off campus housing, residence hall programming, university withdrawals, discipline, drug and alcohol awareness programs and new student orientation. The Department also works closely with the Residence Hall Association and Off Campus Aggies. In addition, Student Affairs serves as a referral source for students who have problems and need to know which campus office to contact (main office in Room 103, YMCA Building).

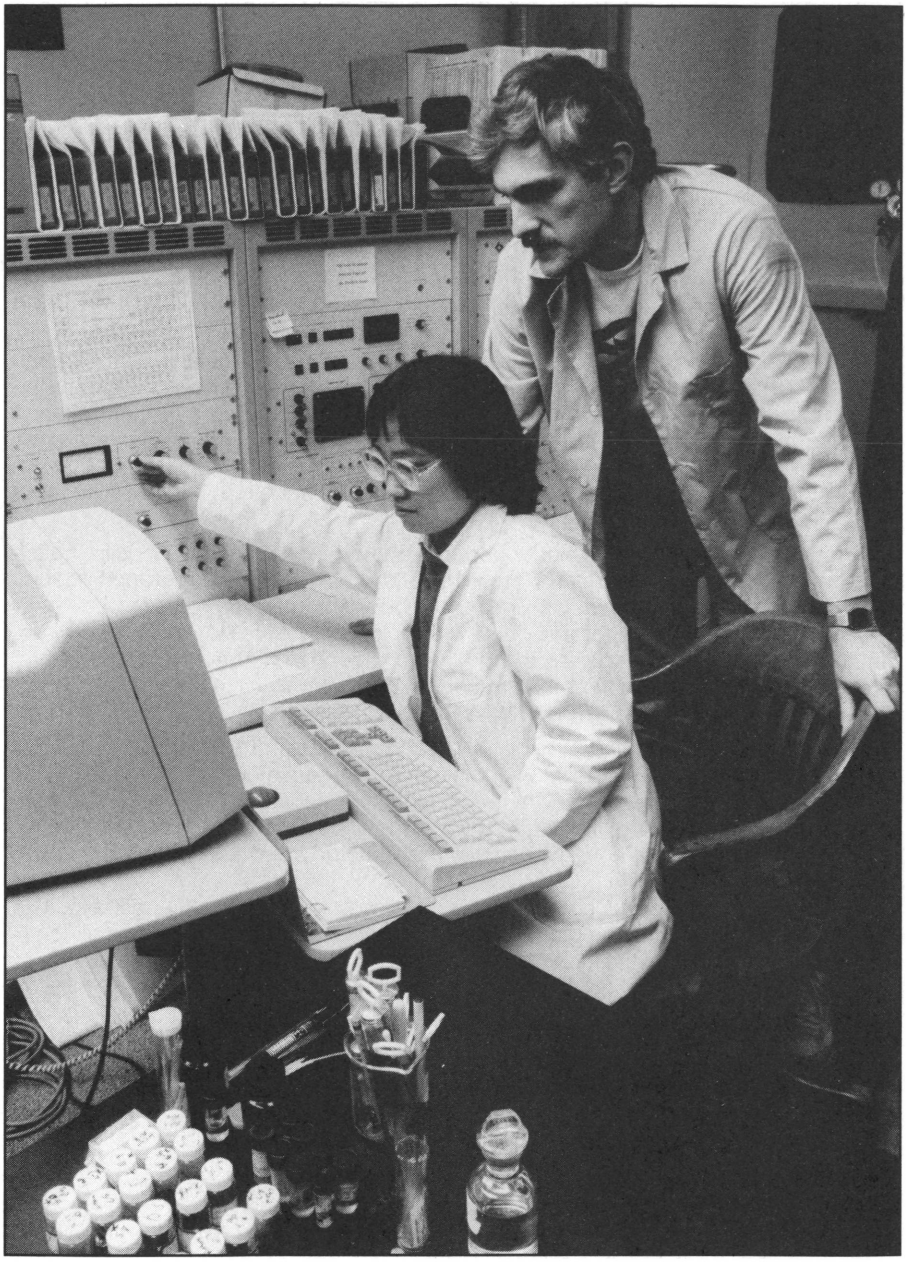
University Health Service provides a modern clinic for out-patient services and beds for 44 in-patients. The facilities of the clinic include a modern laboratory, X-ray, physical therapy, and pharmacy. The medical staff includes not only general practitioners, but also consulting specialists in otorhinolaryngology (ear, nose and throat), surgery, orthopedics, urology, gynecology, dermatology and a satellite counseling service.

The University Health Center is closed during official University holidays. The Health Center fee entitles the student to clinic visits as needed, most diagnostic examinations, care of illnesses or accidents and ten days of treatment(s) per semester for cases requiring hospitalization at the University, and x-rays and laboratory tests as indicated. There is a nominal charge for prescription medications, studies done outside the Health Center and in-patient meals.

The University Health Center does not perform major surgery. In cases of need, the student selects the hospital and surgeon and assumes financial responsibility for surgical or medical procedures. Care will be provided in most cases for post-operative patients. Help will be provided by the Health Center staff.

Coordinator for Handicapped and Veterans provides a number of services which include both academic and mobility assistance for all handicapped students. The Coordinator is also the University Veterans Certification Officer. The office is located on the first floor of Ramp B, Hart Hall. While not a part of the Division of Student Services or of Texas A&M University, the Texas Rehabilitation Commission maintains an office on campus in Room 147 of the MSC with a full-time counselor to assist eligible handicapped students.

TEXAS A&M UNIVERSITY



GRADUATE COURSES

All graduate courses offered in the University are described on the following pages and are listed by departments, arranged alphabetically. Some of the new courses and changes in courses are included in this catalog pending their approval by the Texas Higher Education Coordinating Board.

Figures in parentheses following the number of the courses indicate the clock hours per week devoted to theory and practice, respectively. Theory includes recitations and lectures; practice includes work done in the laboratory, shop, drawing room, or field. The unit of credit is the semester hour, which involves one hour of theory, or from two to four hours of practice per week for one semester of 15 weeks.

Roman numerals to the right of the credit value of some courses indicate the semester in which it is regularly offered. The letter "S" denotes summer offerings.

Any course may be withdrawn from the session offerings in case the number of registrations is too small to justify offering the course.

DEPARTMENT OF ACCOUNTING

N. D. Addy, Jr., J. J. Benjamin (Head), E. D. Bennett, L. L. Bravenec, D. L. Crumbley, D. A. Forgione, G. A. Giroux*, J. M. Holley, V. Karan, S. H. Kratchman, D. R. Lassila, J. R. Miller, B. S. Morris, C. J. Nixon, L. G. Pointer, S. A. Reed, G. L. Schugart, W. T. Shearon, Jr.**, P. D. Shields, L. M. Smith, C. D. Stolle, R. H. Strawser, E. P. Swanson, W. A. Wallace, C. E. Wiggins, Jr., C. J. Wolfe

*Doctoral Student Advisor
**Master's Student Advisor

The Department of Accounting offers graduate studies leading to the M.S. and Ph.D. degrees, and course work supporting the College of Business Administration's M.B.A. degree. The M.S. degree provides the necessary course work for students who wish to enter public accounting, private industry or government service. The Ph.D. program is designed to prepare students for careers in teaching and research.

Additional information, including specific departmental requirements, may be obtained by contacting the master's Student Advisor or the doctoral Student Advisor in the Department of Accounting.

(ACCT)

602. Business Combinations and Accounting Measurements. (3-0). Credit 3. Accounting treatments for business combinations; reporting practices followed by conglomerate companies. Security and Exchange Commission decisions, corporation annual reports and stock exchange listing statements. Case studies. Prerequisite: ACCT 642 or equivalent.

607. Seminar in Auditing. (3-0). Credit 3. Current issues and research in auditing, attestation and financial disclosures. Prerequisite: ACCT 648.

611. Management of Taxation. (3-0). Credit 3. Various income taxes on taxable entities. For business and other majors.

612. Partnership and Real Estate Taxation. (3-0). Credit 3. Concepts and principles of partnerships and real estate taxation; the use of partnerships and real estate for tax planning. Prerequisite: ACCT 405 or 611.

613. Estate Planning. (3-0). Credit 3. Taxation of decedent's estates and lifetime gifts; valuation of property subject to estate and gift taxes; concepts and principles of estate and trust taxation; estate planning. Prerequisite: ACCT 405 or 611.

614. Current Topics in Taxation. (3-0). Credit 3. Selected topics may include compensation techniques, corporate returns, international taxation, real estate taxation. May be taken twice for credit. Prerequisite: ACCT 405 or 611.

615. Oil and Gas Taxation. (3-0). Credit 3. Tax aspects of the acquisition, exploration and development of oil and gas properties including subleases, depletion, sharing arrangements, carried interests, drilling arrangements, tax shelters and windfall profit tax. Prerequisite: ACCT 405, 611 or equivalent.

621. Corporate Taxation I. (3-0). Credit 3. Formation and capital structures, partial liquidations, S corporations, accumulated earnings tax, personal holding companies and other topics. Prerequisite: ACCT 405, 611 or equivalent.

631. Corporate Taxation II. (3-0). Credit 3. Taxation of corporations in business combinations and consolidations, divisions, recapitalizations and other special areas. Prerequisite: ACCT 611.

640. Accounting Concepts and Procedures I. (3-0). Credit 3. Accounting concepts and relationships essential to administrative decisions; use of accounting statements and reports as policymaking and policy execution tools. Prerequisite: Graduate classification. Classification 6 students and non-business graduate students may enroll in specially designed sections of this course.

641. Accounting Concepts and Procedures II. (3-0). Credit 3. Financial accounting; conceptual aspects obtained through the problem approach. Prerequisites: Graduate classification; ACCT 640 or equivalent. Classification 6 students and non-business graduate students may enroll in specially designed sections of this course.

642. Accounting Concepts and Procedures III. (3-0). Credit 3. Advanced financial accounting topics. Theoretical and problematical treatment of accounting in the corporate structure, debt and equity funding, and preparation and analysis of financial statements under conditions of changing economic environment. Prerequisites: Graduate classification; ACCT 641 or equivalent.

648. Accounting Information Systems. (3-0). Credit 3. Design, implementation, operation, control and audit techniques of accounting information systems. Prerequisites: ACCT 641 and BANA 607 or equivalent.

649. Managerial Accounting. (3-0). Credit 3. Cost accounting concepts and use of accounting data in planning and control of operations. Classification 6 students may not enroll in this course. Prerequisite: ACCT 640 or equivalent.

651. Development of Accounting Thought. (3-0). Credit 3. Criteria for choices among income-determination and asset-valuation rules in context of public reporting. Prerequisite: ACCT 642 or approval of instructor.

661. Interdisciplinary Interface of Accounting Thought. (3-0). Credit 3. Implications for accountants of new developments in other disciplines and of changes in the technology and financing of particular industries.

665. Research Methodology I. (3-0). Credit 3. Nature and evaluation of accounting research; includes preparation and evaluation of original research papers. Prerequisite: Doctoral classification.

666. Research Methodology II. (3-0). Credit 3. Research designs in accounting; identification of and approaches to solving the "unanswered questions" in accounting research. Prerequisite: Doctoral classification.

671. Contemporary Accounting Topics. (3-0). Credit 3. Current issues and research in topical areas: financial data audit and control; international accounting; accounting for natural resources; tax planning, theory and structure of taxation. Students select three of the topics available. Prerequisites: Graduate classification; approval of instructor.

679. Managerial Accounting Analysis. (3-0). Credit 3. Primary aspects of managerial accounting needs; planning, internal control, cash and inventory management, data systems and analysis, and mergers and acquisitions. Prerequisite: ACCT 649 or equivalent.

680. Tax Research and Policy. (3-0). Credit 3. Methodology and sources of tax research; tax analysis research, policy implications, behavioral aspects and use of quantitative analysis. Prerequisite: ACCT 405 or 611.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems using recent developments in business research methods. Prerequisites: Graduate classification; approval of instructor.

688. Doctoral Seminar. (3-0). Credit 3. Historical development of the conceptual framework of accounting theory and practices; analysis of current research and controversial issues in the field. For doctoral students only. May be repeated for credit three times. Prerequisite: M.B.A. or equivalent.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of accounting. May be repeated for credit.

690. Theory of Research in Accounting. (3-0). Credit 3. The design of research in the various subfields of accounting and the evaluation of research results using examples from the current research literature. May be repeated for credit. Prerequisites: Graduate classification in accounting.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

ADULT AND EXTENSION EDUCATION

(See Interdisciplinary Education)

DEPARTMENT OF AEROSPACE ENGINEERING

A. Ahmed, D. H. Allen*, L. A. Carlson, W. E. Haisler (Head), A. L. Highsmith, J. L. Junkins, V. K. Kinra, K. D. Korkan, A. J. Kurdila, C. Ostowari, T. C. Pollock, R. A. Schapery, T. Strouboulis, R. E. Thomas, S. R. Vadali, D. T. Ward

*Graduate Advisor

The Department of Aerospace Engineering offers graduate work to provide training in preparation for the practice of aeronautical/aerospace engineering and careers in pertinent areas of research. Programs leading to the degrees of M.Eng., M.S. and Ph.D. are offered. The department also offers courses and faculty supervision for students pursuing the doctor of engineering degree. There are no foreign language requirements in any of these programs. Major areas of interest are fluid mechanics, hypersonics, computational fluid dynamics, flight mechanics, spacecraft dynamics, solid mechanics, propulsion and composite materials.

Wind tunnels provide equipment for aerodynamic research in fundamental fluid flow problems, for atmospheric boundary layer flow about buildings, vehicles and other common structures, and for three-dimensional testing of complete airplane models. Five research aircraft are available for full scale flight research. Investigations of materials and structural mechanics problems are undertaken in the Mechanics and Materials Center. Solutions to complicated fluid and solid mechanics problems are efficiently obtained with university and college mainframe computers and supporting departmental computational facilities.

Courses relating to structural mechanics and materials listed at the end of this section are contained within the "Interdisciplinary Engineering" listing. The mechanics and materials courses are administered by the Department of Aerospace Engineering and are taught by faculty from the Departments of Aerospace, Civil and Mechanical Engineering.

(AERO)

601. Principles of Fluid Motion. (4-0). Credit 4. Formulation of equations of motion for subsonic, transonic and supersonic flow. Classical and numerical solution methods for aerodynamic flow fields. Applications to slender body theory, method of characteristics and drag minimization. Prerequisite: Approval of instructor.

602. The Theory of Fluid Mechanics. (3-3). Credit 4. Entry-level graduate course on the theory of fluid mechanics, employing a wide-range unified approach; concepts of compressibility, turbulence and boundary layer theory. Laboratory includes elements of measurement techniques, numerical methods and physical modeling. Prerequisite: MATH 601 or registration therein.

603. Applied Mechanics for Aerospace Engineers. (3-0). Credit 3. Development of field equations for analysis of aerospace solids and fluids; conservation laws; kinematics, constitutive behavior of solids and fluids; applications to aerospace engineering problems. Prerequisite: Graduate classification.

605. Aeroacoustics I. (3-0). Credit 3. Lighthill's theory, jet noise prediction; introduction to propeller and rotor noise prediction methods; acoustic energy dissipation, finite amplitudes and cases where the simple wave equation is not appropriate are discussed. Prerequisite: Graduate classification.

614. Aeroacoustics II. (3-0). Credit 3. Compact and non-compact noise sources, linear acoustics, and non-linear acoustics applied to propeller and rotor aeroacoustic methodologies; investigation of Hawking's approach as compared to the solution of the Ffowcs Williams-Hawkings equation; case studies. Prerequisite: AERO 605.

615. Numerical Methods for Internal Flow. (3-0). Credit 3. Methods for solving internal flow problems; viscous and inviscid compressible flow, Euler/Navier Stokes solvers, boundary conditions. Prerequisites: MATH 601 and AERO 316; or approval of instructor.

620. Unsteady Aerodynamics. (3-0). Credit 3. Theoretical formulation of unsteady airfoil theory and techniques used for determining airloads on oscillating lift surfaces. Exact solutions and various approximations presented and evaluated. Application to problems of unsteady incompressible, subsonic and transonic flows about airfoils and wings. Prerequisite: Approval of instructor.

622. Spacecraft Dynamics and Control. (3-0). Credit 3. Modeling different types of spacecraft and control systems, sensors, and actuators; stability; control system design; attitude estimation; attitude and orbital coupling; environmental effects. Prerequisite: AERO 422 or ELEN 420.

623. Optimal Spacecraft Attitude and Orbital Maneuvers. (3-0). Credit 3. Application of optimization and optimal control techniques to spacecraft maneuver problems; computation of open loop and feedback controls for linear and nonlinear spacecraft dynamical systems; case studies. Prerequisite: AERO 423 or equivalent.

624. Celestial Mechanics. (3-0). Credit 3. Analytical and numerical methods for computing spacecraft orbits under the influence of gravitational, aerodynamic, thrust and other forces; Keplerian two-body problem, perturbation methods, orbit determination, navigation and guidance for aerospace vehicles. Prerequisite: AERO 423 or equivalent.

630. Aerodynamics of the Helicopter. (3-0). Credit 3. General aerodynamic theory of rotating-wing aircraft. Development of the theory in its elemental form emphasizing basic concepts. Hovering and vertical flight performance analyses. Aerodynamics and performance of forward flight. Prediction and effects of rotor blade stalls. Prerequisite: AERO 301 or 601.

660. Nonlinear Flight Dynamics. (3-0). Credit 3. Nonlinear equations of motion for coupled aircraft motions; coupled aerodynamic phenomena; application of the direct method of Lyapunov to nonlinear aircraft motions; elastic airplane equations of motion. Prerequisite: AERO 421 or approval of instructor.

671. Panel Method Techniques in Aerodynamics. (3-0). Credit 3. Theory and application of lifting surface and non-lifting surface panel methods in aerodynamics; development of vortex lattice, source, and doublet panels as well as higher order methods; application to incompressible, subsonic, and supersonic wings and wing-bodies. Prerequisite: AERO 301 or equivalent.

672. Advanced Numerical and Compressible Aerodynamics. (3-0). Credit 3. Nonlinear transonic flow including two and three dimensional analysis and design techniques. Compressible subsonic panel theory with emphasis on problem formulation and boundary conditions. Designing and programming nonlinear aerodynamic methods. Prerequisite: AERO 303, 320 or equivalent.

674. Inviscid Hypersonic Flow. (3-0). Credit 3. Theoretical formulation of invsicid hypersonic flow theory; techniques for hypersonic vehicle flowfield analysis; high temperature effects, including both equilibrium and nonequilibrium flows; classical and modern computational methods. Prerequisite: AERO 303 or equivalent.

675. Aerodynamic Heating. (3-0). Credit 3. Analysis of compressible laminar and turbulent boundary layers in high-speed flows; convective aerodynamic heating. Prerequisite: AERO 475 or approval of instructor.

676. Aerothermochemistry. (3-0). Credit 3. Fundamentals of kinetic theory, chemical thermodynamics, and statistical mechanics; applications to high temperature chemically reacting equilibrium and nonequilibrium aerodynamic flows. Prerequisite: AERO 303 or equivalent.

681. Seminar. (1-0). Credit 1. Selected research topics will be presented by the faculty, students, and outside speakers. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Special topics not within scope of thesis research and not covered by other formal courses. Prerequisite: Graduate classification in aerospace engineering.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of aerospace engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Technical research projects approved by department head.

The following MEMA courses (Mechanics and Materials found in the Interdisciplinary Engineering section) are part of the curriculum in aerospace engineering and are taught by the faculty of the Department of Aerospace Engineering.

601. Theory of Elasticity. (3-0). Credit 3.
605. Energy Methods. (3-0). Credit 3.
611. Engineering Fracture Mechanics. (3-0). Credit 3.
612. Wave Propagation in Isotropic and Anisotropic Solids. (3-0). Credit 3.
613. Principles of Composite Materials. (3-0). Credit 3.
620. Processing and Testing of Composite Materials. (2-3). Credit 3.
632. Structural Stability. (3-0). Credit 3.
633. Theory of Plates and Shells. (3-0). Credit 3.
641. Plasticity Theory. (3-0). Credit 3.
646. Introduction to the Finite Element Method. (3-0). Credit 3.
647. Theory of Finite Element Analysis. (3-0). Credit 3.
648. Nonlinear Finite Element Methods in Structural Mechanics. (3-0). Credit 3.
689. Special Topics in . . . Credit 1 to 4.

The following MEMA courses are part of the curriculum in aerospace engineering but are normally taught by faculty of other engineering departments.

607. Flow and Fracture of Solids. (3-0). Credit 3.
608. Elasticity of Structural Elements. (3-0). Credit 3.
609. Materials Science. (3-0). Credit 3.
610. Applied Polymer Science. (3-0). Credit 3.
618. Designing with Composites. (2-3). Credit 3.
636. Theory of Thermal Stresses. (3-0). Credit 3.
640. Theory of Shells. (3-0). Credit 3.
650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3.
651. Viscoelasticity of Solids and Structures I. (3-0). Credit 3.
652. Viscoelasticity of Solids and Structures II. (3-0). Credit 3.

DEPARTMENT OF AGRICULTURAL ECONOMICS

S. H. Amosson, D. A. Bessler*, F. O. Boadu, O. Capps, Jr., D. T. Chen, G. M. Clary, J. R. Conner, E. E. Davis, R. A. Dietrich, R. A. Edwards, W. F. Edwards, D. E. Farris, R. L. Floyd, S. W. Fuller, H. L. Goodwin, Jr., W. R. Grant, R. C. Griffin, W. L. Griffin, W. A. Hayenga, L. L. Jones, R. D. Kay, D. A. Klinefelter, T. O. Knight, R. D. Knutson, R. D. Lacewell, C. F. Lard, D. J. Leatham, L. A. Lippke, K. K. Litzenberg, A. C. Lovell, J. R. Martin, M. A. Mazzocco, B. A. McCarl, J. M. McGrann, J. W. Mjelde, J. P. Nichols, T. Ozuna, D. I. Padberg (Head), J. B. Penson, Jr., W. Peterson, J. W. Richardson, M. E. Rister, F. J. Ruppel, I. W. Schmedemann, V. E. Schneider, R. B. Schwart, Jr., C. E. Shafer, C. R. Shumway, E. G. Smith, T. L. Sporleder, K. W. Stokes, J. R. Stoll, H. Talpaz, P. B. Thompson, M. L. Waller, G. W. Williams

*Graduate Advisor

The objective of the Department of Agricultural Economics is to train scientific and professional workers. Increasing attention of public agencies and private organizations to rural economic and social problems points to enlarged opportunities for well-qualified graduates for teaching, research, public administration, management and private employment.

In planning a student's program, the need for broad training, rather than narrow specialization, is recognized. The student, regardless of his or her primary interest, is expected to take not only advanced courses covering various fields within the department but also essential supporting courses in other departments. In all cases the student is expected to acquire a knowledge of economic theory, its application to contemporary agricultural problems, and the ability to employ statistical techniques and other methodology in making social and economic studies.

The teaching and research activities are grouped broadly as follows: (1) farm management and production economics, (2) marketing and market development, (3) resource and real estate economics, (4) agricultural finance, (5) rural development and (6) agricultural policy. The present and expanding program of research in the department affords the student a wide choice and capable guidance in thesis or dissertation research.

The M.S. degree in agricultural economics may or may not require a thesis and is oriented to the basic professional requirements. Graduates receiving the Master of Agriculture degree have been employed in the following areas: (1) agribusiness management, (2) agribanking, (3) commodity analysis, (4) real estate economics, (5) international agricultural development. A professional internship rather than a thesis is required. The Ph.D. program concentrates on the theory, quantitative tools and methodology required of the professional agricultural economist.

No foreign language requirement is stipulated for students pursuing a Ph.D. program in agricultural economics.

(AGEC)

601. Commodity Futures and Options Markets. (3-0). Credit 3. Price risk management using agricultural commodity futures and options markets, detailed examination of theories of hedging and formulation of optimal hedging strategies, various applied hedging strategies evaluated and compared with emphasis placed on options relative to futures, relationship of options to farm policy. Prerequisites: One course in calculus and one course in statistics.

602. Agricultural Market Organization and Structure. (3-0). Credit 3. Framework within which farm products are marketed. Implications of horizontal and vertical integration and governmental activities. Influence on market structure of producers, the food and fiber industries, and consumers. Prerequisite: ECON 607 and MATH 230 or equivalent.

603. Land Economics. (3-0). Credit 3. Selected problems of allocation and use of natural resources with special reference to government organizations, quasi-governmental bodies and other interest groups. Prerequisite: AGEC 422 or equivalent.

604. Natural Resource Economics. (3-0). Credit 3. Critical evaluation of policies and procedures in natural resource development and use. Identification of problems in resource development, the political-economic decision-making processes and analytical tools which can contribute to economic decisions.

605. Rural Real Estate Appraisal and Organization. (3-0). Credit 3. Concepts of property rights and their valuation; factors affecting the value of these rights are related to general economic theory to explain real estate market process. Specific applications of appraisal techniques in valuing urban and rural real properties. Prerequisite: AGEC 422.

606. Range Economics. (3-0). Credit 3. Application of economic and financial tools for improved managerial decision-making in the range-livestock industry. Prerequisite: Graduate classification in the College of Agriculture. Cross-listed with RASC 606.

607. Research Methodology. (3-0). Credit 3. Scientific method in economic research: problem identification and selection, hypothesis testing, assumptions, model selection, data communication. Evaluation of research studies and development of thesis prospectus or equivalent.

609. Applied Welfare Economics. (3-0). Credit 3. Social benefits and costs of policy alternatives for commercial agriculture, natural resource development and public investment in agricultural research; general equilibrium and welfare economics including consumers' and producers' surplus; benefit-cost analysis; applications from contemporary agricultural economics literature. Prerequisite: ECON 629.

610. Advanced Natural Resource Economics. (3-0). Credit 3. Current and emerging problems in natural resource economics: factors contributing to natural resource quality and quantity changes; natural resources in relation to current agricultural technology, economic problems, environmental issues, legal and political constraints and institutions. Prerequisites: AGEC 604 and ECON 629 or AGEC 609.

611. Production Economics I. (3-0). Credit 3. Economic principles for analyzing agricultural production and resource use; problems are treated regarding the technical unit, the firm and society; conditions for efficiency. Prerequisites: ECON 607 and MATH 230 or equivalent.

612. Economic Development of Rural Areas. (3-0). Credit 3. Economic problems of rural areas in the U.S. Review of fundamental causes of economic decline in rural areas. Application of economic principles and theory to problems of rural areas. Evaluation of current methods and public programs for development. Application of analytical methods to development problems.

614. Agricultural Policy. (3-0). Credit 3. Public policies and programs affecting agriculture and agribusiness; development of policies and programs, identifying relevant issues, reviewing past and projecting future means to attain desired goals, and development of methods to evaluate the consequences of alternative farm policies on U.S. agriculture, agribusinesses and trade.

615. Agricultural and Food Policy Analysis. (3-0). Credit 3. Advanced analytical base for understanding, evaluating and formulating farm and food policy. Economic analyses developed and applied to selected contemporary policy issues. Prerequisite: Approval of instructor.

617. Market Development Research Theory. (3-0). Credit 3. Emergence of market development concepts, practices and strategies for products. Causes, effects and relationships to business and consumer economics and psychological behavior theories. Market development technical research methods and operations.

619. Agricultural Business Analysis. (3-0). Credit 3. For master of agriculture students. Practical application of modern decision-making tools to agribusiness. Management process, basic functions of managing, and important managerial and economic skills and understanding needed to carry out these functions.

620. Capital Market in Agriculture. (3-0). Credit 3. Selected micro and macro economic issues in agricultural finance. Application of economic and finance theory with appropriate quantitative methods to financial management in agriculture and financial markets serving agriculture. Prerequisites: AGEC 630, 611, 641, STAT 608 and ECON 611, or equivalent.

621. Quantitative Techniques for Decision-Making in Agriculture. (3-0). Credit 3. Quantitative decision-making techniques in agricultural businesses; emphasis on computer analysis using small business computers, quantitative techniques including linear programming, simulation and regression used in agricultural firms. Corequisite: STAT 651.

627. Agricultural Market and Price Analysis. (3-0). Credit 3. Application of economic theory and statistical methods to the analysis of agricultural commodity price behavior; price forecasting; relationships among farm prices, marketing costs and retail prices. Prerequisites: AGEC 447 and STAT 608 or equivalent.

630. Financial Planning of the Farm Firm. (3-0). Credit 3. Application of financial planning principles to farm business firms: capital budgeting and selection of farm investments; the role of debt structure and liquidity in firm growth and stability; how to build, merchandize and manage a firm's "credit"; alternatives for gaining control over resources and maintaining business efficiency over time.

632. Production Economics II. (3-0). Credit 3. Theory of the firm applied to problems of product supply, input demand and resource allocation; major estimation and data issues. Prerequisites: ECMT 669, AGEC 611 or ECON 630; ECMT 664.

633. Economics of Underdeveloped Agricultural Areas. (3-0). Credit 3. Survey of agricultural development issues and conceptual approaches to the study of agricultural and economic development in less developed countries; topics include agricultural production, technological change, marketing, trade and the evaluation of government policies; familiarity with intermediate-level economic theory is required.

634. Economics of Agricultural Production. (3-0). Credit 3. Application of economic principles to crop and livestock units, stressing amounts and combinations of inputs required for most profitable production. Design of experiments in the physical sciences to permit economic evaluation of results. For non-agricultural economics students in the College of Agriculture.

641. Operations Research Methods in Agricultural Economics. (3-0). Credit 3. Quantitative methods applying operations research tools appropriate to problem-solving and decision-making. Current operations research techniques in various areas of economic research. Model application and electronic data processing techniques. Prerequisites: STAT 651, MATH 230 or equivalents.

642. Systems Analysis and Programming in Agricultural Economics. (3-0). Credit 3. Theory, algorithms and applications of dynamic optimization in deterministic and stochastic settings applied to agricultural economics systems; analytical methods include dynamic programming, calculus of variations and optimal control. Prerequisite: AGEC 641.

644. Law and Agriculture. (3-0). Credit 3. Laws affecting agricultural firms and individuals in day-to-day farm and ranch decision-making; legal arrangements and issues in intensive livestock operations; agronomic marketing practices; agricultural use of herbicides, insecticides and pesticides; other current legal issues. Prerequisite: Graduate classification.

645. Agricultural Consumption Analysis. (3-0). Credit 3. Specification, estimation and interpretation of models of consumer behavior with emphasis related to farm economy and food commodities. Building and evaluating food consumption models. Prerequisites: ECON 629, STAT 608, ECMT 664.

655. Agricultural Marketing Operations. (3-0). Credit 3. Commodity system: structure and performance; forces of change affecting responses of marketers to change within. Practical management: analysis, planning, organization and control. Prerequisites: AGEC 314, ECON 203, or equivalent.

661. Applied Econometric Methods in Agriculture. (3-0). Credit 3. Application of econometric methods in a theoretical framework for the analysis of agricultural markets and farm firm behavior. Emphasis on specifying and estimating agricultural production and demand functions and agricultural sector models. Selected topics according to student needs.

681. Seminar. (1-0). Credit 1 each semester. Review of current literature, preparation of papers on selected topics, application of the problem solving approach, discussions with visiting agricultural economists and related professionals.

684. Professional Internship. Credit 1 to 4. A work-study course for master of agriculture program in agricultural economics.

685. Problems. Credit 1 to 4 each semester. Directed individual study of a selected problem in the field of agricultural economics.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of agricultural economics. May be repeated for credit.

691. Research. Credit 1 or more each semester. Initiation and completion of a research project of approved scope for an advanced degree.

DEPARTMENT OF AGRICULTURAL EDUCATION

G. E. Briers, H. D. Brown* (Head), J. E. Christiansen*, K. L. Denmark, D. R. Herring*, A. Larke, Jr., D. C. Pfannstiel, J. D. Townsend

*Graduate Advisor

The Department of Agricultural Education offers graduate studies leading to the degrees of master of education, master of agriculture with an option in agricultural development, master of science, doctor of philosophy and doctor of education.

Advanced study in agricultural education or agricultural development is designed to help agricultural professionals to work with people. Professionals such as teachers of agriculture at secondary and postsecondary institutions, agricultural extension personnel, international development specialists, teacher educators in agriculture, curriculum specialists, and a wide array of private and public sector professionals who are responsible for the introduction of change may improve their capabilities through a program of selected courses and experiences. Program planning and program implementation receive emphasis. Course content and teaching procedures used in graduate courses are selected to assist in the development of skills in recognizing and analyzing professional problems and initiating plans of action for the solution of these problems.

Candidates for master's degrees in agricultural education or in agricultural development should have at least one year of successful professional experience or should plan for an internship in a specific career in professional agriculture or education. Evidence of maturity, purposefulness, and scholastic ability may be considered in lieu of experience upon approval of the faculty and the head of the department. Candidates for doctoral degrees must have at least three years of successful professional experience.

The staff of the department maintains continuous contact with agricultural professionals in the field. These contacts enable faculty members to conduct graduate programs with understanding and appreciation of important and complex problems encountered by professional agricultural workers.

(AGED)

601. Advanced Methods in Agricultural Education. (3-0). Credit 3. Learning theories; techniques and procedures to enhance the teaching-learning process; methods to evaluate learning. Prerequisite: Approval of department head.

602. Problem Analysis in Teaching Vocational Agriculture. (3-0). Credit 3. Designed for teachers of agricultural science and for those returning to the profession. Problems encountered by teachers identified, analyzed and resolved. Prerequisite: Approval of department head.

605. Supervision of Occupational Experience Programs in Agriculture. (3-0). Credit 3. Occupational experience programs — their nature and scope in relation to supervised activities in agriculture, part-time agricultural cooperative experiences and pre-employment laboratories. Prerequisite: Approval of department head.

607. Youth Leadership Programs. (3-0). Credit 3. Methods and procedures of organizing and conducting youth leadership programs in school and non-school settings. Prerequisite: Professional experience or approval of department head.

610. Principles of Adult Education. (3-0). Credit 3. Identification of basic principles motivating adults to learn. Procedures to implement these principles in bringing about changes in adult behavior. Prerequisite: Professional experience or approval of department head.

615. Philosophy of Agricultural Education. (3-0). Credit 3. Historical and philosophical developments in education that brought about education in agriculture; ideas of individuals that culminated in agricultural education institutions and organizations. Prerequisite: Approval of department head.

619. Workshop in Agricultural Education. Credit 1 to 3. Offered for three or six weeks or full semester to study selected problems in agricultural or extension education. Consultants are used in specialized areas. May be taken twice for credit but not to exceed 6 hours of credit toward a degree. Prerequisite: Professional experience or approval of department head.

630. Guidance and Counseling for Rural Youth. (3-0). Credit 3. Problems of youth with special attention given to rural youth. Theories of vocational development reviewed and techniques and procedures developed to help youth make career choices. Prerequisite: Approval of department head.

640. Methods of Technological Change. (3-0). Credit 3. Dynamics of cultural change as theoretical framework for planned technological change; methods of planning and implementing change, its effects and how it can be predicted. Prerequisite: Approval of department head.

641. The Transfer of Technology by Institutions. (3-0). Credit 3. Role and organization of institutions for effective transfer of technology; institutional models, assignment of priorities, institutional linkages, communications, special program design, program strategies and program evaluation. Prerequisite: Professional experience or approval of department head.

644. The Agricultural Advisor in Developing Nations. (3-0). Credit 3. Trends, conditions, critical incidents, techniques, roles, and preparation affecting the success of persons desiring to provide technical assistance in projects of agricultural development by serving as agricultural advisors in developing nations, especially in cross-cultural settings. Prerequisite: Approval of instructor.

645. Initiating, Managing, and Monitoring Projects of International Agricultural Development. (3-0). Credit 3. Origin of projects in agricultural development involving host governments; procedures in developing contracts with sponsors; duties and responsibilities of contract administrators, project leaders, and the home institution; reporting systems, project reviews, and evaluation procedures; procedures effective in managing projects. Prerequisite: AGED 640 or approval of instructor.

646. Institutions Serving Agriculture in Developing Nations. (3-0). Credit 3. Comparisons among programs and functions, strengths and weaknesses, organization, and relationships of institutions and agencies in public sectors serving agriculture in developing nations; includes those responsible for agricultural extension, agricultural research, agrarian reform, price stabilization, agricultural credit, and agricultural cooperatives. Prerequisite: AGED 641 or approval of instructor.

647. Field Studies in Agricultural Development. (2-2). Credit 3. Orientation to, analysis, and appraisal of representative programs of agricultural development; field trip required to study agricultural development in a developing nation; primarily for graduate students with little or no experience working in an international setting. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. Group study and discussion of current developments in agricultural education. Research and legislation as they affect programs in teacher education, agricultural science and related areas of education. Prerequisite: Approval of department head.

684. Professional Internship. Credit 1 to 6 each semester. An on-the-job supervised experience program conducted in the area of the student's specialization. Prerequisites: Graduate classification; approval of department head.

685. Problems. Credit 1 to 4 each semester. Studies related to classroom, laboratory, supervised activities in agriculture, work experience, extension education and adult educational activities in agricultural programs. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of agricultural education. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. Initiation and completion of research for advanced degree. Prerequisite: Approval of department head.

DEPARTMENT OF AGRICULTURAL ENGINEERING

W. H. Aldred, D. A. Bender*, C. R. Bogle, L. F. Bouse, C. G. Coble, G. L. Curry, C. L. Darcey, W. A. Dugas, Jr., C. R. Engler, G. Fipps, A. Garcia III, J. L. Goodenough, E. A. Hiler, O. R. Kunze*, W. A. LePori*, W. M. Lyle, A. R. McFarland, M. J. McFarland, J. E. Morrison, Jr., C. B. Parnell, D. L. Reddell* (Interim Head), S. W. Searcy, B. A. Stout, D. A. Suter, V. E. Sweat, J. M. Sweeten, A. D. Whittaker, L. H. Wilkes, J. A. Witz, M. L. Wolfe, W. L. Zingery

*Graduate Advisor

The Department of Agricultural Engineering offers graduate studies leading to the degrees of master of science, master of engineering and doctor of philosophy. In addition, the department offers the master of agriculture degree in mechanized agriculture and courses and faculty supervision for students pursuing the doctor of engineering degree. Faculty expertise exists for study in fields such as machinery, product processing, microelectronic applications, structures, soil and water, food engineering, animal environment, agricultural waste management and pollution abatement, biochemical engineering (in cooperation with the Department of Chemical Engineering) and forest engineering (in cooperation with the Department of Forest Science). Supporting advanced courses are available in a wide variety of disciplines as well as within the department.

Minimum preparation for entry into advanced study would include a baccalaureate degree in engineering. Students with baccalaureate degrees in non-engineering disciplines will be accepted but must take some basic engineering courses in addition to their graduate courses.

Excellent facilities for research are available, including modern laboratories, testing equipment, technical support and field plots.

(AGEN)

601. Research Methods and Control Systems Theory. (3-0). Credit 3. Theory of control systems analysis with applications to living systems. Research and modeling in thermoregulation and other biological control areas. Prerequisite: Approval of department head.

602. Irrigation and Drainage. (3-0). Credit 3. Theory and practice in irrigation and drainage. Soil moisture, moisture flow, hydraulics of wells, erosion and sedimentation of structures, and theory of water application methods. Salinity and sodicity and their control. Drainage methods and theory, steady state and non-steady state. Prerequisites: MATH 308, AGRO 445 or approval of department head.

603. Agricultural Machinery. (3-0). Credit 3. Functional farm machinery design. Analysis of problem need, functional requirements, common materials used, design, testing and production of efficient operational units. Prerequisite: Approval of department head.

610. Digital Logic and Microcomputer Applications in Agriculture. (2-3) Credit 3. Development and application of electronic, hydraulic and fluidic digital logic circuits. Principles of microcomputer programming, operation and interfacing; use of digital logic and microcomputers in agricultural control applications. Prerequisites: PHYS 219 and AGEN 430 or equivalent.

611. Hydraulic and Power Transmission Systems for Tractors. (2-2). Credit 3. Theory and application of hydraulic and power transmission systems used in agricultural tractors. Laboratory practice includes study of application and use of hydraulic and power transmission systems related to the functional requirement of tractors. For non-engineering graduate students. Prerequisite: AGEN 330 or approval of department head.

612. Planning and Management of Irrigation Systems. (2-2). Credit 3. Planning and management of irrigation systems; surface, sprinkler, trickle and subsurface irrigation systems. The total system: sources of water, water rights, economics, water requirements, distribution systems, water measurement, system efficiencies, drainage, pollution and water conservation. For non-engineering graduate students. Prerequisite: AGEN 335 or approval of department head.

613. Small Watershed Hydrology. (3-0). Credit 3. Hydrology of agricultural watersheds; soil and water conservation, precipitation frequency analysis, infiltration, groundwater, runoff, erosion theory, sediment transport theory, evapotranspiration, reduction of water losses and experimental techniques. Prerequisite: MATH 308 or approval of department head.

614. Advanced Metals and Welding Processes. (2-4). Credit 4. Metals, welding metallurgy and welding processes. Practice includes certification requirements and techniques in tube welding, template construction, material preparation and inert gas welding. For non-engineering graduate students. Prerequisite: AGEN 222 or approval of department head.

615. Measurement Techniques in Agricultural Engineering. (2-3). Credit 3. Agricultural measurement systems; soil, water and humidity devices and instruments for quality evaluation and control of agricultural products; measurement of product maturity and ripeness, inspection of grains and seeds, animal carcass quality and milk fat analysis. Prerequisite: AGEN 430 or approval of department head.

616. Remote Sensing Applications in Water Resources. (3-0). Credit 3. Available sensors, capability and limitations of sensors, developing technology and sensor-platform combinations. Water resources models studied to determine variables that can be remotely measured. Current data processing and interpretation techniques demonstrate applications in water resources problems. Prerequisite: Approval of instructor.

620. Food Rheology. (2-3). Credit 3. Principles of elasticity, viscous flow and visco-elasticity applied to solid and liquid food materials. Experimental determination of rheological properties using fundamental methods and empirical textural measurements. Applications to food engineering research, textural measurement and quality control. Prerequisites: FSTC 213, MATH 230, PHYS 201 and graduate classification.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology; application to the design, development and improvement of industrial processes that employ biological materials. Engineering discipline directed toward creative application of interdisciplinary information to the economic processing of biological and related materials. Prerequisite: Approval of instructors. Offered jointly by agricultural engineering, bioengineering and chemical engineering and cross-listed with BIEN 651 and CHEN 651.

652. Biochemical Processing Technology. (3-0). Credit 3. Introduction for engineers to biochemistry, microbiology and genetic engineering; important processes in biotechnology such as enzymes, food, pharmaceuticals, waste treatment, fuels and chemicals, agricultural products and biotransformations. Prerequisite: AGEN 651, BIEN 651 or CHEN 651. Cross-listed with CHEN 652.

653. Bioreactor Design. (3-0). Credit 3. Kinetics of enzyme reactions and cell growth applied to bioreactor design, media formulation, cell culture conditions, oxygen transfer, and sterilization. Prerequisite: AGEN 651, BIEN 651 or CHEN 651 or approval of instructor.

654. Separation Processes in Biochemical Engineering. (3-0). Credit 3. Theory and practice in isolation and purification of biological materials; properties of biological compounds; processing to retain biological activity of enzymes and other biomaterials; scale-up of separation processes; laboratory demonstrations of current technology. Prerequisite: AGEN 651, BIEN 651 or CHEN 651. Cross-listed with CHEN 654.

661. Systems Engineering Applications in Agriculture. (3-0). Credit 3. Engineering applications of operations research methodology to agricultural production systems; optimal crop harvesting schedules, irrigation scheduling, irrigation system design optimization, machinery selection and machinery dynamics. Prerequisite: Approval of department head.

662. Statistical Modeling and Simulation of Biological Systems. (3-0). Credit 3. Statistical aspects of simulation modeling applied to problems in agriculture and forestry; probability distribution fitting to complete and censored data; generating independent and correlated random deviates; statistical analysis of simulation output; variance reduction techniques. Prerequisites: STAT 601 and INEN 625 or equivalent.

681. Seminar. (1-0). Credit 1 each semester. Reviews, reports and discussion of ideas, recent advances and current topics.

684. Professional Internship. Credit 1 to 4. An on-the-job supervised experience program, conducted on an individual basis in the area of the student's specialization in mechanized agriculture. Prerequisite: Graduate classification or approval of instructor.

685. Problems. Credit 1 to 4 each semester. Advanced laboratory or field problems not related to student's thesis. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of agricultural engineering. May be repeated for credit.

690. Theory of Research. (1-0). Credit 1. Development of research inquiry and discussion of applicable experimental design, theoretical techniques and methodological principles of conducting original research. Evaluation of current research of faculty and students and in engineering and scientific literature. Communication of research proposals and results. May be repeated for credit. Prerequisites: Graduate classification and approval of department head.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

AGRONOMY

(See Soil and Crop Sciences)

DEPARTMENT OF ANIMAL SCIENCE

J. F. Baker, F. M. Byers, J. Caldwell, M. C. Calhoun, Z. L. Carpenter, T. C. Cartwright, R. S. Chapkin, B. E. Conrad, C. E. Coppock, H. R. Cross, S. K. Davis, C. W. Dill, J. W. Edwards, R. L. Edwards*, W. C. Ellis, J. W. Evans, D. W. Forrest, T. H. Friend, T. R. Greathouse, L. W. Greene, P. G. Harms, D. B. Herd, J. H. Hesby, J. W. Holloway, D. P. Hutcheson, J. T. Keeton, G. T. King, D. A. Knabe, D. C. Kraemer, K. S. Kubena, H. O. Kunkel, A. L. Lawrence, H. Lippke, C. R. Long, D. K. Lunt, J. R. Lupton, C. S. Menzies, W. L. Mies, R. K. Miller, G. D. Potter, R. D. Randel, K. S. Rhee, R. L. Richter, J. O. Sanders, J. W. Savell, J. M. Shelton, G. C. Smith (Head), S. B. Smith, L. R. Sprott, E. M. Sudweeks, J. F. Taylor, W. B. Thomas, G. B. Thompson, M. Tomaszewski, J. W. Turner, C. Vanderzant, J. P. Walter, T. H. Welsh, Jr., G. L. Williams, C. G. Woelfel

*Graduate Advisor

Advanced study in animal science offers preparation for a future in teaching, research, extension, livestock and dairy production, and in industries involving food technology, livestock products and livestock management. Majors offered are:

Animal breeding	M.S. and Ph.D.
Animal science	M.S., M.Agr. and Ph.D.
Dairy science	M.S., M.Agr. and Ph.D.
Food science and technology	M.S., M.Agr. and Ph.D.
Nutrition	M.S. and Ph.D.
Physiology of reproduction	M.S. and Ph.D.

The animal science subject matter fields are strongly supported by course work in agricultural economics, biochemistry, biophysics, biology, genetics, statistics, and in veterinary anatomy, microbiology, parasitology, pathology, physiology, pharmacology and public health.

Laboratories available for graduate research include cytogenetics, dairy manufacturing, food technology, meats, muscle biology, nutrition and reproductive physiology. The Robert Justus Kleberg, Jr. Animal Science Center provides 39 laboratories for research and graduate training. Special equipment available in these laboratories or in readily accessible facilities, such as at the Computing Services Center, offers a wide array of opportunities for study and research.

Dairy, beef, horse and swine herds and sheep and goat flocks at the main station or at research centers afford opportunities to study various problems in physiology, breeding, management, nutrition and production. A dairy processing plant equipped to manufacture all dairy foods on a semi-commercial scale, and the Rosenthal Meat Science and Technology Center, equipped to fabricate and process all meat foods on a semi-commercial scale, are in operation and are available for research problems.

Experiment Station projects in all subject matter fields offer opportunities for graduate students to participate in current research activity.

Support areas such as biochemistry and biophysics, economics, genetics and statistics may be readily arranged. Food science and technology courses are jointly listed.

There is no specific foreign language requirement for the doctor of philosophy degree. A student's Advisory Committee may require a foreign language or additional course work in an unrelated area in lieu of a foreign language.

ANIMAL SCIENCE
(ANSC)

601. General Animal Nutrition. (3-0). Credit 3. I Nutritional, metabolic and physiological functions of the whole animal. Prerequisites: ANSC 303 and 318 or equivalent or approval of department head.

602. Protein and Energy Nutrition. (3-0). Credit 3. II Current fundamental concepts in protein and energy metabolism relating to nutrients required for maintenance, growth and development of animals. Prerequisite: BICH 410 or approval of department head.

603. Experimental Nutrition. (1-6). Credit 3. II Laboratory and animal procedures applicable to nutrition research with emphasis on the principles and techniques of sample collection and analysis. Prerequisite: BICH 410 or approval of department head.

604. Ruminant Nutrition. (3-0). Credit 3. I Current concepts in anatomy, physiology of digestion and metabolism in ruminant nutrition and their relationships to nutrition practice and research with emphasis on ruminants. Prerequisites: ANSC 601 or 602, BICH 411 or 603 and/or approval of department head.

605. Advancements in Beef Cattle Production. (3-0). Credit 3. I Current knowledge and concepts in production of lean beef; review of research in beef cattle production, breeding, nutrition, reproduction and economics. Prerequisites: ANSC 305, 318 and 406 or approval of department head.

606. Advancements in Beef Cattle Production. (3-0). Credit 3. II Continuation of ANSC 605 with emphasis on efficiency of growth and development of diverse types of cattle through computer simulation of beef production systems. Prerequisites: ANSC 307, 318 and 406 or 408 or approval of department head.

607. Physiology and Biochemistry of Muscle as a Food. (3-0). Credit 3. II Biochemical, histological, anatomical and physical factors associated with transformation of muscle cell into meat. Prerequisite: BICH 410 or approval of department head. Cross-listed with FSTC 607.

608. Beef Cattle Management. (3-0). Credit 3. S Current knowledge of beef cattle ranch and feedlot production systems; nutrition, management, breeding, body composition, economics, health, pollution and sanitation control. Prerequisite: ANSC 406 or 408.

609. Physiology of Growth and Stress in Livestock. (3-0). Credit 3. Basic biochemical, physiological and endocrine mechanisms involved in processes regulating metabolism, growth and stress in livestock; current research and management principles/concepts useful to study growth and stress physiology; anabolic agents, anti-stress agents, immunoneutralization; transgenic livestock. Prerequisites: BICH 410, 411; VTPP 601, 602; or equivalents; or approval of instructor.

610. Behavior and Training of Domestic Animals. (2-2). Credit 3. I Review and evaluation of current research, points of controversy, importance of behavior in experimentation and management of species important to agriculture. Behavior principles are integrated with applied aspects. Research projects on behavior are developed and conducted by students in area of interest. Guest lecturers prominent in ethology lead several discussions.

611. Equine Nutrition. (3-0). Credit 3. II Review and evaluation of current research in equine nutrition; principles of digestive physiology and nutrition unique to equine species; comparative digestion; integration of scientific principles into feeding management systems to enhance productivity, health and longevity of the equine. Prerequisite: ANSC 601 or approval of department head.

612. Equine Reproduction. (3-0). Credit 3. I Review of current research relating to equine reproductive physiology and endocrinology; concepts from current research in equine reproduction to develop integrated reproductive management systems for horses. Prerequisites: ANSC 433; graduate classification.

616. Quantitative Genetics II. (3-0). Credit 3. II Theories and methods useful in quantitative genetics research; estimation of genetic parameters and their precision; genetic discriminant functions; and experimental design and interpretation. Prerequisites: GENE 613; STAT 608, 619.

617. Experimental Techniques in Meat Science. (1-6). Credit 3. I Methods used in separating and identifying muscle proteins and fats. Techniques for determining postmortem changes of muscle tissue as a result of antemortem treatments. Prerequisites: BICH 604 or 411 and ANSC 607.

619. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. I Review of research relating to sheep and goat production; specifically, genetics and animal breeding, physiology of reproduction and meats. Evaluation of potential application for research to improve efficiency of production and economic return. Consideration of research methodology, techniques and analyses. Prerequisites: ANSC 305, 414; or approval of department head.

620. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. II Continuation of ANSC 619 with consideration of nutrition, fiber production and marketing, diseases, parasites, physical facilities and management.

621. Advancements in Swine Production. (3-0). Credit 3. II Review of research relating to various phases of pork production. Evaluation of research and application of basic principles to efficient management. Economic requirements and current production problems. Prerequisites: ANSC 305, 412; or approval of department head.

628. Animal Breeding. (2-2). Credit 3. II Concepts from Mendelian, population and quantitative genetics; heritability, selection response, selection criteria, selection index, genetic relationship, inbreeding, mating systems, hybrid vigor and genetic-environmental interaction applied to livestock breeding and to production systems. Interactions between genetics and nutrition, reproduction, production and management for both established concepts and recent trends are emphasized according to special interests of students. Prerequisite: ANSC 305 or POSC 414.

631. Physiology of Reproduction. (2-2). Credit 3. I Basic biochemical, physiological and endocrine mechanisms involved in reproductive function. Current research principles and techniques useful in studying physiology of reproduction. Prerequisites: ANSC 433, BICH 410, VTPP 601 and 603, or approval of department head.

633. Concepts in Reproduction. (3-0). Credit 3. II Concepts from current research in physiology of reproduction will be evaluated and applied for enhancement of livestock production efficiency. Ovulation control, embryo transfer, multiple births and control of parturition. Prerequisite: ANSC 433 or equivalent or approval of department head.

647. Technology of Meat Processing and Distribution. (3-0). Credit 3. II Quantitative and qualitative characteristics of meat and meat products as related to food technology processing operations; manufacturing, preservation, packaging and merchandising. Cross-listed with FSTC 647.

650. Issues in Animal Agriculture. (3-0). Credit 3. I, II, S Nonmarket factors related to food production and consumption. National and global nutritional, environmental, ethical, social, and political issues faced by agricultural systems. Animal agriculture is used as a model. Prerequisite: Approval of instructor.

667. Industrial Processed Meat Operations. (2-2). Credit 3. II Application of scientific principles and business practices to manufactured meat products. Interrelationships among marketing, manufacturing, product development, regulatory compliance and quality assurance in commercial processed meat operations. Prerequisite: Approval of instructor. Cross-listed with FSTC 667.

681. Seminar. (1-0). Credit 1 each semester. I, II Important current developments in field of animal science. Review of current literature and presentation of papers on selected animal science topics. Prerequisites: Graduate classification in animal science.

684. Professional Internship. Credit 1 to 4. I, II, S Experience in the application of formal training to a commercial operation under supervision of the operations manager and a designated faculty member. The student will investigate a matter of mutual interest to the enterprise manager and to Texas A&M University; will collect, analyze and interpret the data and report the results in a professional paper approved by his or her graduate committee.

685. Problems. Credit 1 to 4 each semester. I, II, S Advanced studies in animal science problems and procedures. Problems assigned according to experience, interest and needs of individual student. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. I, II, S Special topics in an identified area of animal science. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. I, II, S Investigations leading to student's thesis or dissertation in fields of animal production, meats, wool and mohair, nutrition, inheritance of farm animals and physiology of reproduction.

DAIRY SCIENCE
(DASC)

601. Dairy Production. (2-6). Credit 4. I Dairy production problems; research literature. Several principles are studied in search of a bio-economic model to improve production efficiency. Prerequisites: DASC 418 or equivalent; STAT 651.

606. Microbiology of Foods. (3-0). Credit 3. II Nature and function of beneficial and defect-producing bacteria in foods. Food-borne illness, effects of processing, storage and distribution. Techniques for isolation and identification from foods. Cross-listed with FSTC 606.

684. Professional Internship. Credit 1 to 4. I, II, S Application of formal training in a commercial operation under the supervision of a manager and a designated faculty member. Data will be collected on a study of mutual interest to the enterprise manager and Texas A&M University. The student will collect, analyze and report the data, as well as experience. Prerequisite: Minimum of 20 hours of master's credit or approval of department head.

685. Problems. Credit 1 to 4 each semester. I, II, S Research methods and review of scientific literature dealing with individually selected problems in production or manufacturing and not pertaining to thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. I, II, S Special topics in an identified area of dairy science. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. I, II, S Research leading to thesis or dissertation in respective fields of dairy production and dairy manufacturing.

DEPARTMENT OF ANTHROPOLOGY

G. F. Bass, V. M. Bryant, Jr. (Head), D. L. Carlson, N. Dannhaeuser, K. A. Dettwyler, D. B. Dickson, T. A. Green*, S. A. Grider, D. L. Hamilton, H. J. Shafer, D. G. Steele, J. R. Steffy, N. D. Thomas, F. H. van Doorninck, Jr., M. R. Waters

*Graduate Advisor

The Department of Anthropology offers programs of study and research leading to the M.A. and Ph.D. in anthropology. Students enrolled within these programs receive training preparing them for professional research and/or teaching careers in academic institutions, governmental agencies, museums or private industry. The department has a well-rounded program in anthropology with offerings in cultural anthropology, archaeology, physical anthropology and folklore. The department is particularly noted for its strength and emphasis in the fields of nautical archaeology, archaeological conservation, archaeological palynology, geoarchaeology, paleoethnobotany, historical archaeology, lithic technology, physical anthropology and zooarchaeology.

Seven fully-equipped, modern laboratories help the Department of Anthropology carry out its primary function of teaching and providing research facilities for its staff, students and faculty. These laboratories are maintained by the department and are available for graduate student use. In addition, graduate students have access to the use of word processors, computer terminals, field vehicles and the worldwide facilities and equipment utilized and maintained by the Institute of Nautical Archaeology. Other on-campus facilities available for use by graduate students in anthropology include the Electron Microscopy Center, the Computing Services Center and the Evans Library containing over one million volumes and periodicals.

Because of the interdisciplinary nature of the graduate program in anthropology, students with baccalaureate degrees in fields other than anthropology also are en-

couraged to apply. Once admitted to the graduate program, students may elect to concentrate their academic and research efforts in one or more areas within the Department of Anthropology. The degree plan is prepared by the individual student with the assistance of a Faculty Advisory Committee and the course work is kept flexible (within the guidelines of graduate studies) in order to allow students to pursue their individual professional goals. In addition, whenever possible graduate students are encouraged to gain teaching and/or research experience as assistants within the department.

(ANTH)

601. Evolutionary Anthropology. (3-0). Credit 3. Analysis and application of evolutionary theory in the study of human development.

602. Archaeological Methods and Theory. (3-0). Credit 3. Development of archaeology as a discipline. Methods and theories used in archaeology for reconstructing cultural history and culture process.

604. Cultural Method and Theory. (3-0). Credit 3. Survey of the theoretical concepts used in anthropology and how to construct models used in cultural and social anthropology.

605. Conservation of Archaeological Resources I. (3-3). Credit 4. Fundamentals and applications of artifact conservation techniques in archaeology. Prerequisite: Knowledge of basic chemistry and physics recommended.

606. Conservation of Archaeological Resources II. (3-3). Credit 4. Comprehensive study of techniques used in the identification and conservation of metal and wooden artifacts. Prerequisite: ANTH 605.

607. Historical Archaeology. (3-0). Credit 3. Past and present theoretical positions and research strategies in historical archaeology. Prerequisite: ANTH 313 recommended.

612. Preclassical Seafaring. (3-0). Credit 3. Seafarers and watercraft of the ancient Near East and Mediterranean until ca. 700 B.C. Types of watercraft used, routes, cargoes, voyages of exploration and economics of maritime trade. Cross-listed with GEOG 612.

613. Classical Seafaring. (3-0). Credit 3. Culture history of Mediterranean seafarers between ca. 700 B.C. and end of Byzantine Empire. Types of ships and boats, sea law, naval tactics, harbor-works, routes, cargoes and economics of trade. Cross-listed with GEOG 613.

615. History of Shipbuilding Technology. (3-0). Credit 3. Design and construction of preserved and excavated sailing ships, the expertise of their builders and technology involved in ancient and early shipbuilding. Prerequisite: Approval of instructor. Cross-listed with GEOG 615.

616. Research and Reconstruction of Ships. (2-2). Credit 3. Techniques of recording and interpreting excavated ships; preservation of hulls; ship drafting, modeling, lofting, testing and other methods used in the research and/or reconstruction of ships. Prerequisite: Approval of instructor. Cross-listed with GEOG 616.

618. Medieval Seafaring in the Mediterranean. (3-0). Credit 3. Cultural history of seafaring in the Mediterranean region during medieval times; ship types and their uses, naval warfare, sea law, harborworks, routes and cargoes, and maritime economic institutions and practices. Prerequisite: ANTH 316/GEOG 316 or approval of instructor.

619. Medieval Seafaring in Northern Europe. (3-0). Credit 3. Cultural histroy of seafaring in northern Europe during medieval times; ship types and their uses, naval warfare, sea law, harborworks, routes and cargoes, and maritime economic institutions. Prerequiste: ANTH 316/GEOG 316 or approval of instructor.

621. Prehistoric Technology. (3-0). Credit 3. Role of technology in meeting the cultural needs of human populations from prehistoric times to the Middle Ages.

624. Geoarchaeology. (3-0). Credit 3. Application of geological concepts and methods to archaeological research; history of geoarchaeology; site formation processes; modification of archaeological sites and sediments; landscape reconstruction and change and their effects on human behavior. Prerequisite: ANTH 602 or equivalent.

625. Zooarchaeology. (3-3). Credit 4. Analysis of animal bones from archaeological sites. Inference of how prehistoric peoples hunted, domesticated and used animals. Prerequisite: Basic knowledge of zoology and archaeology.

626. Human Paleopathology. (3-0). Credit 3. Pathological lesions exhibited in prehistoric or early historic human remains; problems in diagnosing lesion in fossil skeletal remains, and evaluating the occurence of these lesions in past populations. Prerequisite: ANTH 425.

627. Human Paleonutrition. (3-0). Credit 3. Evaluation of past human diets and subsistence patterns from the perspective of research in archaeology, zooarchaeology, ethnobotany, bioarchaeology and cultural anthropology. Prerequisite: Six hours of advanced courses in anthropology or approval of instructor.

634. Palynology. (3-3). Credit 4. Principles and techniques used in palynology, pollen morphology, ontogeny, biochemistry, dispersion and preservation. Role of palynology as a research tool in plant taxonomy agriculture, medicine, paleobotany and anthropology.

637. Paleoethnobotany. (3-3). Credit 4. Interrelationship between plants and humans from prehistoric times to present, theoretical and methodological use of botany as a research tool for the understanding of cultural systems.

641. Applied Anthropology. (3-0). Credit 3. Theory, ethics and practical applications of anthropological methods and concepts as they relate to planned programs of socio-cultural change.

642. Research Design in Anthropology. (3-0). Credit 3. Research design used by anthropologists to develop sampling strategies, test hypotheses and compile quantitative data. Prerequisites: ANTH 602 and STAT 652 or equivalent.

650. Ethnographic Field Methods. (3-0). Credit 3. Methods common to anthropology for the field collection of data on cultural behavior. Prerequisites: Graduate classification and approval of instructor.

660. Field Archaeology. Credit 1 to 12 each semester. Field instruction in the methods of archaeological excavations; recovery and cataloging of cultural, floral and faunal remains; and interpretation of these data. Locations of the field course will vary according to site. Field trips required. May be taken more than once but not to exceed 8 hours of credit toward an M.A. degree and not to exceed 12 hours of credit toward a Ph.D. degree. Prerequisite: ANTH 602 or equivalent.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research, selected published technical reports and other issues relevant to anthropology.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in anthropology. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of anthropology. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Anthropology. (3-0). Credit 3. Design of research in the various subfields of anthropology and the evaluation of student topical areas, research designs and expertise of current research literature. Prerequisites: Graduate classification in anthropology and approval of department head.

691. Research. Credit 1 or more. Research for thesis. Prerequisite: Approval of graduate advisor.

693. Research Application in Anthropology. (3-0). Credit 3. Supervised analysis and reporting of research topic within selected area of anthropology. Prerequisites: ANTH 690 and approval of department head.

DEPARTMENT OF ARCHITECTURE

E. E. Allen, P. R. Berke, I. D. Bishop, L. L. Boyer, C. D. Claycamp, R. R. Davison, Jr., L. O. Degelman, D. C. Ekroth, J. G. Fairey, J. O. Greer, J. M. Gribou, A. C. Hamblett, W. W. Harper, M. E. Heck, R. C. Hill, K. Hillier-Woodfin, W. G. Horsley, J. M. Hutchinson, S. M. Kirchman, T. R. Larsen, T. E. Linehan, D. F. MacGilvray, G. L. Maffei, T. S. Maffitt, Jr., G. J. Mann, J. L. Mashburn*, J. J. McGraw, G. J. Moore, V. L. Paul, M. J. Pereau, D. Poniz, L. L. Priesmeyer, M. W. F. Quantrill, R. D. Reed, J. W. Rogers, E. J. Romieniec, R. J. Schiffhauer, A. D. Seidel, A. L. Stacell, R. E. Vrooman, J. W. Walker, W. V. Wells (Interim Head), W. V. Wendler, C. White, D. G. Woodcock

*Graduate Advisor

The Department of Architecture offers programs of advanced study as preparation for professional careers in architecture. Degrees include the master of architecture as a first professional degree accredited by NAAB, the master of architecture as a post-professional degree and the doctor of philosophy in architecture. Entry to the former is directly from a pre-architecture four-year degree or, with appropriate prerequisite work, from other four-year degree backgrounds. In addition to a core program in architecture students undertake studies in an area of emphasis approved by the department. Current areas include architectural design, architectural history and preservation and interior architecture. Supporting course work is available in computer applications to design, energy conservation, management in architecture, health facility programming and design, structural technology, life safety and urban design.

(ARCH)

605. Architectural Design I. (2-12). Credit 6. Design processes using architectural projects as case studies. Assigned projects. Design experience includes schematic design: program development, concept formulation, design methodologies, graphic and verbal communication skills. Core design studio for professional degree candidates.*

606. Architectural Design II. (2-12). Credit 6. Continuation of ARCH 605. Design experience; schematic design and design development: selection and design of structural systems, building services, materials, connections and equipment. Core design studio required for professional degree candidates. Prerequisite: ARCH 605 or equivalent.*

607. Architectural Design III. (2-12). Credit 6. Individually directed design studios. Advanced analysis, synthesis and appraisal techniques responding to contemporary architectural issues. Prerequisite: ARCH 606 or equivalent.*

608. Architectural Design IV. (2-12). Credit 6. Individually selected design project of major architectural significance and complexity. Professional documentation required. Project requires approval of instructor. Prerequisite: ARCH 607 or equivalent.

621. Energy Optimization in Building Design. (3-0). Credit 3. Optimum energy use strategies for buildings, energy audit methods, life-cycle cost analysis of building energy systems, solar system applications, building system optimization by computer simulation techniques, case studies in passive energy and solar applications. Prerequisites: ARCH 633 and CPSC 203 or equivalent.*

623. Design Methods I. (3-0). Credit 3. Importance of intuitive methods in design; meaning, symbolism and creativity in art and architecture; techniques to develop creative approaches to problem-solving.

625. Design for Life Safety. (3-0). Credit 3. Principles of life safety in building design to reduce potential for loss of life under fire, earthquake, hurricane or windstorm conditions. Life safety in conjunction with building codes and standards and other legal contexts and professional liability. Prerequisites: ARCH 631 and 633 or approval of instructor.

631. Structural Systems. (3-0). Credit 3. Structural analysis of building structural systems: components, frames, shapes. Selection and economics of structural systems. Survey of current structural design codes. Supervision practices in structural construction. Prerequisite: Nine hours of structures.

633. Environmental Control Systems. (3-0). Credit 3. Building energy consumption patterns and conservation strategies. Natural and mechanical subsystems for environmental control. Subsystem design criteria, economic considerations and selection methods. Prerequisite: COSC 336.*

634. Architectural Lighting. (1-2). Credit 2. Attributes of the lighting environment, lighting and energy issues, daylight availability, building design for daylighting, heat loss control, solar shading, daylighting models, graphical analytical and computer methods of analysis, visual and lighting comfort evaluation, integration of daylight and electric light, energy analysis. Prerequisite: ARCH 633 or approval of instructor.

635. Architectural Acoustics. (1-2). Credit 2. Nature of sound, acoustic design criteria, measurements, sound absorption, reverberation, airborne and solidborne sound transmission, speech privacy, mechanical equipment noise, good hearing requirements, auditorium design, building project evaluations. Prerequisite: ARCH 633 or approval of instructor.

639. Contemporary Architecture. (3-0). Credit 3. Twentieth century architecture; development of style, structure, materials, social and economic factors influencing architecture. Discussion and criticism of work and writings of architects and architectural theorists. Prerequisite: ARCH 449 or approval of instructor.

640. Morphology of Architectural Form. (3-0). Credit 3. Forces influencing structure and form of architecture: climate, culture, site, economics, construction methods. Prerequisite: Graduate classification.

642. Data Processing in Environmental Design. (2-3). Credit 3. Application of the computer to architectural problems. The computer as a mapping device for graphical display of spatially related data; simple and multiple linear regression on sets of data; correlation analyses and practice at running the computer for these applications.

646. Historic Building Preservation. (3-0). Credit 3. History of the preservation movement in the U.S. Architectural and regulatory techniques employed in building preservation. Case study of selected examples. Prerequisite: Graduate classification.*

647. Recording Historic Buildings. (1-5). Credit 3. Techniques for recording historic buildings; measuring and drawing to Historic American Building Survey Standards. Field experience in photography, field notes and record drawing preparation. Prerequisites: Graduate classification and appropriate background in architectural drawing.*

657. Professional Practice. (3-0). Credit 3. Business and legal environment; design and construction industry; legal forms of practice; office organization, personnel practices, policies and management; basic and expanded professional services; economics of practice, profit planning and accounting; client selection; standard forms of agreement between design professionals, consultants and clients; professional ethics; relationships and forms of construction, bidding and contract documents; standard conditions of construction contracts; selection of contracts; project procedures and administration; professional liability. Prerequisites: MGMT 212; graduate classification.

661. Interior Component Selection and Design. (2-4). Credit 3. Standard lines of furniture and accessories; methods of selection; theory and application in designing components; furniture, accessories and architectural graphics. Prerequisite: Approval of instructor.*

663. Interior Architecture I. (2-4). Credit 3. Theory and application of interior architectural programming and design processes using small scale interior architectural projects as case studies. Design as a synthesis of human perception, user's background of behavior, sociological makeup, design tools and systematic predictions. Prerequisite: Approval of instructor.*

665. Interior Architecture II. (2-12). Credit 6. Professional solutions to interior architectural problems on a broad scale; feasibility studies, cost estimating, design execution, specifications and construction documents. Prerequisite: ARCH 663 or equivalent.*

666. Interior Architecture III. (2-12). Credit 6. Individually selected design of significance and complexity that focuses on interior architecture issues. Prerequisites: ARCH 665 or equivalent and approval proposal.

681. Seminar. (1-0). Credit 1 each semester. Discussion and review of current practice in architecture and environmental design.

684. Professional Internship. Credit 1 to 8. Professional practice under approved arrangement with public or private agencies or in residence to complement academic course work and to provide the basis for, and allow the preparation of, an appropriate report. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 6 each semester. Individual problems involving application of theory and practice in design and construction of buildings and groups of buildings. Prerequisite: Approval of instructor and department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in architecture and environmental design. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Architecture. (3-0). Credit 3. Design of research in various sub-fields of architecture, evaluation of research results using examples from current research literature. May be repeated for credit. Prerequisite: Graduate major in architecture or related field.

691. Research. Credit 1 or more each semester. Research for and preparation of dissertation.

693. Professional Study. Credit 1 to 23 each semester. Approved professional study or project undertaken as the terminal requirement for the master of architecture. May be taken more than once but not to exceed 6 hours of credit toward a degree. Prerequisite: Approved proposal.

*Field trips may be required for which departmental fees may be assessed to cover costs.

DEPARTMENT OF BIOCHEMISTRY AND BIOPHYSICS

C. J. Arntzen, E. Ashworth-Tsutsui, T. O. Baldwin*, G. W. Bates, C. R. Benedict, P. F. Fitzpatrick, E. A. Funkhouser, A. S. Garay, D. P. Giedroc, J. M. Gunn*, E. D. Harris, L. L. Keeley, G. R. Kunkel, H. O. Kunkel, T. M. Lohman*, J. M. Magill, E. F. Meyer, J. E. Mullet, J. Nagyvary, B. C. O'Brien, C. N. Pace, W. D. Park, D. O. Peterson, D. W. Pettigrew, F. M. Raushel, A. I. Scott, M. D. Summers, J. R. Wild (Interim Head), C.-H. Wong, R. D. Wood, R. F. Young

*Graduate Advisor

The Department of Biochemistry and Biophysics offers programs of study and research leading to the M.S. and Ph.D. degrees in biochemistry and the M.S. degree in biophysics. These programs are designed to provide the background for a career in independent research; in addition, graduate students gain experience in teaching, inasmuch as each is required to serve as a teaching assistant for at least three semesters during his or her graduate work. A non-thesis option for the M.S. degree is available to students not intending to enter a research career.

The department is well-equipped for conducting research at the forefront of biochemistry. Specialized items of equipment include an X-ray diffractometer and an interactive computer graphics display; a variety of spectrophotometers for study in the UV, visible and IR, including stopped-flow spectrophotometers, an atomic absorption spectrophotometer, a fluorescence spectrophotometer and a spectropolarimeter; two high-resolution mass spectrometers, one equipped with Cf-plasma desorption; NMR spectrometers; various liquid scintillation and gamma-ray counters; analytical and preparative ultracentrifuges; a variety of electrophoretic instruments; modern high pressure liquid chromatography equipment; a large scale bacterial fermentation facility; a facility for microscale amino acid analysis; peptide synthesis, peptide and protein sequencing and oligonucleotide synthesis; and fully equipped tissue culture laboratories including a P-3 facility.

Research activities in the department involve plants, animals, and microorganisms and span the broad fields of molecular biology, proteins, lipids, nucleic acids, intermediary metabolism, biophysical chemistry and biochemical nutrition. More specifically, current research interests include the control of gene expression in plants, animals and bacteria, transcriptional regulation of hormone-responsive genes, studies *in vitro* of protein-nucleic acid interactions involved in replication, recombination and gene expression, plant molecular biology of chloroplast biogenesis, heat and drought stress responses and tissue specific nuclear gene expression, molecular mechanism of bacteriophage-induced cell lysis, enzymology and enzyme mecha-

nisms, conformational stability of proteins, structure-function relationships in proteins, analysis of active sites by computer graphics, investigation of zinc domains by multinuclear NMR, mechanisms of protein turnover and regulation of intracellular protein degradation, lipid chemistry and metabolism, structural analysis of membrane lipids, control of serum cholesterol, biochemistry and mechanism of action of polypeptide hormones and the regulation of trace mineral metabolism.

Students entering graduate work in biochemistry or biophysics are required to have adequate preparation in chemistry, mathematics, physics and modern molecular biology. The program leading to the Ph.D. degree is designed so that the student experiences extensive involvement in research. The resulting dissertation must demonstrate a superior knowledge and understanding of the subject area. In addition, the student must demonstrate a broad and commanding knowledge of general biochemistry. There is no language requirement at the M.S. level. The Ph.D. language requirement is determined by the student's Advisory Committee in order to meet individual needs related to the research program. There is, however, an English requirement for all students, including those seeking the M.S. degree, who are found to be deficient in writing skills. The department encourages interdisciplinary research projects with other departments. Detailed information about the graduate program may be obtained from the Graduate Coordinator.

BIOCHEMISTRY
(BICH)

603. General Biochemistry I. (3-0). Credit 3. The biochemical properties of macromolecules found in living matter. Proteins, enzymes, and nucleic acids. Prerequisites: CHEM 228, 316, 323.

604. General Biochemistry II. (3-0). Credit 3. Continuation of BICH 603. Metabolic regulation. Photosynthesis. The biochemical properties of lipids and carbohydrates. Prerequisite: BICH 603.

607. Methods of Biochemical Analyses. (1-6). Credit 3. Laboratory investigation of biological molecules and the relationships between their structures and functions. Prerequisites: BICH 410 and 411 or equivalent.

624. Enzymes, Proteins and Nucleic Acids. (3-0). Credit 3. Chemical and physical properties of enzymes, proteins and nucleic acids. Thermodynamics, kinetics and mechanisms of enzyme-catalyzed reactions and protein-nucleic acid interactions. Prerequisites: BICH 603; CHEM 324.

631. Biochemical Genetics. (3-0). Credit 3. Genetic control of cellular metabolism; mechanism of gene action; gene-enzyme relationships; regulation of gene expression; structure and organization of genomes; biochemical manipulation and characterization of genetic molecules. Prerequisites: BICH 603 and GENE 431. Cross-listed with GENE 631.

641. Nutritional Biochemistry. (3-0). Credit 3. Mechanisms of nutrient digestion, absorption, transport, assimilation and utilization in the normal and diseased state. Prerequisite: BICH 411 or 604. Cross-listed with NUTR 641.

642. Metabolic Regulation. (3-0). Credit 3. Regulation of metabolic pathways and alterations associated with various metabolic disorders. Prerequisite: BICH 604.

681. Seminar. (1-0). Credit 1 each semester. Original articles in biochemistry and related fields designed to broaden understanding of problems in the field and to stimulate research.

685. Problems. Credit 1 or more each semester. Biochemical laboratory procedures; preparations and instrumentation. Problems assigned according to experience, interests and needs of individual student. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of biochemistry. May be repeated for credit. Prerequisite: BICH 604.

690. Theory of Biochemical Research. (2-0). Credit 2. State-of-the-art examination of modern trends in various subfields of modern biochemistry concentrating on the design of experiments, evaluation of research results and discussion of the current literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Laboratory facilities available for original investigations in various phases of biochemistry. Prerequisite: Approval of major advisor.

695. Frontiers in Biochemical Research. (2-0). Credit 2. The present status and historical perspective of a variety of significant biochemical fields. Content will depend on availability of visiting lecturers. May be taken twice. Prerequisite: BICH 604.

See GENE 631 for full description of related course.

BIOENGINEERING

(See Industrial Engineering)

DEPARTMENT OF BIOLOGY

K. J. Aufderheide, M. J. Benedik, G. Bhaskaran, J. C. Carrington, V. M. Cassone, E. R. Cox, K. H. Dahm, W. P. Fife, B. G. Foster, J. W. Golden, S. S. Golden, I. F. Greenbaum, L. R. Griffing, T. C. Hall (Head), D. E. Harper, Jr., J. E. Kanz, W. M. Kemp, D. S. MacKenzie, J. R. Manhart, M. D. Manson, T. D. McKnight, D. M. J. Mueller, C. L. Nessler, D. W. Owens, E. T. Park, C. O. Patterson, S. M. Ray, P. J. Rizzo, H. W. Sauer, G. L. Schroeter, M. H. Sweet, B. H. Taylor, T. L. Thomas, K. A. VandenBosch, K. P. VanWinkle-Swift, P. J. Weldon, M. K. Wicksten, H. D. Wilson

Resources for Graduate Study

The Department of Biology offers graduate programs designed to prepare students for careers in academic institutions, government agencies and industry. The Biological Sciences Complex is centrally located on the campus of Texas A&M University. Graduate research is emphasized in over 50 laboratories that contain modern and sophisticated instrumentation for cellular, molecular, physiological and ecological studies. These laboratories provide opportunities for a broad spectrum of research specializations. The Electron Microscopy Center and a state-of-the-art DNA sequencing laboratory are among the many facilities housed in the Biological Sciences Complex.

Texas A&M University is a member of the Organization for Tropical Studies. Graduate students are eligible to apply to use laboratory facilities in Costa Rica for botanical or zoological field studies. The Biology Department Herbarium, the Tracy Herbarium, and the Texas Cooperative Wildlife Collection provide access to excellent collections of Texas plants and animals. Provisions for research in marine biology are available in Galveston. In addition, The Texas A&M University System, The University of Texas System and Baylor College of Medicine have agreements relating to cooperative use of courses and facilities in graduate education.

The Department of Biology faculty has research interests which interface with those of faculty in the Colleges of Agriculture and Life Sciences, Geosciences, Medicine and Veterinary Medicine. Cooperation is encouraged to broaden the research experience of graduate students. In addition, some faculty members in the Department of Biology have appointments in the interdisciplinary faculties of genetics and plant physiology.

Areas of Specialization in Graduate Research

Cellular and Developmental Biology — plant protoplast and tissue culture, transformation and regeneration; ultrastructure and function; genetics of development and differentiation; nuclear organization; developmental endocrinology; cell surface interactions; physiology of photosynthesis.

Evolutionary Biology — Modern and classical approaches to plant and animal systematics and evolution; genomic and biochemical evolution; cytogenetics.

Molecular Biology — DNA and RNA isolation, cloning and sequencing; gene isolation, characterization, transfer and expression; bacterial and phage genetics; molecular processes of differentiation and embryogenesis; parasite immunology; molecular microbiology and virology.

Organismal Biology — Comparative endocrinology and physiology; parasite biology; vertebrate chemoecology; invertebrate ecology and ethology; marine biology.

Entrance Requirements

Course work taken at the baccalaureate level normally must include mathematics through calculus, statistics, chemistry including organic chemistry, biochemistry, physics, genetics and adequate preparation in a biological science. Any remedial work will be in addition to the semester hours required for the degree.

Graduate Degrees

Biology (Cellular, Molecular and Developmental)	M.S. and Ph.D.
Botany	M.S. and Ph.D.
Genetics (see Genetics, Graduate Catalog)	M.S. and Ph.D.
Microbiology	M.S. and Ph.D.
Plant Physiology (see Plant Physiology, Graduate Catalog)	M.S. and Ph.D.
Zoology	M.S. and Ph.D.

Language Requirement

The Department of Biology has no foreign language requirement for any graduate degree program.

BIOLOGY
(BIOL)

The doctor of philosophy degree program in biology is designed to provide the student with training in cellular, molecular, and developmental biology, and to prepare the student for a leadership position in academic or industrial research. The Department of Biology offers a broad spectrum of research opportunities including plant molecular biology, molecular and cell biology of differentiation and development, gene structure and regulation in eukaryotic and prokaryotic organisms and their viruses, and cell structure and function. Students obtaining a degree in biology may also work closely with faculty in biochemistry, entomology, genetics, plant physiology, medicine and veterinary medicine.

Biology Ph.D. students must demonstrate competence in their specific area of research and are expected to develop proficiency in four of the following six areas at the time of the preliminary examination: biochemistry, cell biology, developmental biology, genetics, microbiology and molecular biology. An M.S. student must demonstrate competence in at least three of the above six areas at the time of the final examination.

602. Transmission Electron Microscopy. (3-6). Credit 5. Methods of studying biological material with the transmission electron microscope, fixation, ultra-microtomy, cytochemistry, replica and shadowing, and other biological related procedures. Prerequisite: approval of instructor received one month prior to registration.

611. Molecular Biology of Differentiation and Development. (3-0). Credit 3. Major paradigms of eukaryotic gene regulation in terms of the role of gene expression during ontogeny and the effect of dysfunction in these processes on the neo-plastic state.

615. Cytology. (3-3). Credit 4. Structure and ultrastructure of cells; relationship between structure and function at cellular and sub-cellular levels; structural and ultrastructural aspects of cell division.

616. Biochemical Systematics and Evolution. (3-3). Credit 4. Theory, use and applications of electrophoretic techniques as applied to systematics, taxonomy, evolution and population genetics; project planning isozyme techniques, analysis and interpretation of data covered through individual electrophoretic studies in lab. Prerequisites: BICH 410 and 411, ZOOL 605 or WFSC 601, GENE 603 or equivalent.

617. Cell Biology. Credit 1 to 5. Structure and function of eukaryotic cells discussed on a comparative basis to seek out basic organization of complex cells and their parts. Prerequisite: BIOL 413 or approval of instructor. Cross-listed with VTAN 617.

628. Scanning Electron Microscopy. (2-4). Credit 3. Principles of electron interaction with solids; application of secondary and backscatter electron images. Prerequisite: approval of instructor one semester prior to registration.

674. Cellular and Molecular Aspects of Development. (3-0). Credit 3. Mechanisms of development at the cellular and molecular levels; gene regulation during embryogenesis; tissue interactions in relation to morphogenesis and differentiation, and pattern formation. Emphasis on eukaryotic systems. Prerequisite: BIOL 413 or 421 or equivalent.

681. Seminar. (1-0). Credit 1. Detailed reports on specific topics in field chosen. Students may register in up to but no more than three sections of this course.

685. Problems. Credit 1 to 6 each semester. Limited investigations in fields other than those chosen for thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of biology.

690. Theory of Research. (3-0). Credit 3. Design of research experiments in biology and the evaluation of research results with the aid of examples taken from the current literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

BOTANY
(BOTN)

The aims of a doctor of philosophy degree program in botany are to train the student to do original and imaginative research in the botanical sciences, to develop the student's ability to expertly judge current research, and to provide experience and training in the presentation and publication of scientific findings. The Department of Biology offers the opportunity for research in plant cell and molecular biology, organismal plant biology, and plant systematics and evolution. Association with other departments could emphasize various aspects of plant science, such as physiology, genetics, pathology, horticulture, crops and forestry.

Botany Ph.D. students must demonstrate competence in their specific area of research and are expected to develop proficiency in four of the following six areas: biochemistry/molecular biology, cell biology, genetics, physiology, structure/development and systematics. In addition, the candidate should have a sufficient depth-of-knowledge of the organism or system used in the dissertation research. An M.S. student must demonstrate competence in at least three of the above six areas at the time of the final examination.

608. Phycology. (3-3). Credit 4. Morphology, systematics, ecology and physiology of fresh water and marine algae. Discussion of current literature. Laboratory stresses systematics and physiology. Three day collecting trip to the Texas coast required. Prerequisite: BOTN 408 or approval of instructor.

619. Plant Biosystematics. (3-3). Credit 4. Experimental and analytical approaches to plant variation and evolution, breeding systems, cytogenetics, hybridization and phylogeny. Prerequisite: BOTN 201 or equivalent or approval of instructor.

620. Field Systematic Botany. (2-6). Credit 4. Basic principles and concepts of seed plant systematics; procedures of identification, family recognition, terminology, nomenclature, herbarium techniques, systems of classification and the taxonomic literature. Prerequisite: BOTN 201 or equivalent or approval of instructor.

623. Plant Morphology. (2-6). Credit 4. Anatomical, reproductive, ontogenetic and phylogenetic features of vascular plants representing major plant taxa. Prerequisite: BOTN 327 or equivalent.

625. Bryology. (3-3). Credit 4. Morphology, systematics and ecology, field studies of mosses, liverworts and hornworts. Prerequisite: approval of instructor.

681. Seminar. (1-0). Credit 1. Detailed reports on specific topics in field chosen. Students may register in up to but no more than three sections of this course.

685. Problems. Credit 1 to 6 each semester. Limited investigations in fields other than those chosen for thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of botany.

690. Theory of Research. (3-0). Credit 3. Design of research experiments in botany and the evaluation of research results with the aid of examples taken from the current literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

MICROBIOLOGY
(MICR)

The Ph.D. program in microbiology is designed to train the students in laboratory science, to provide the factual background necessary for research, and to develop the critical faculties with which to judge scientific findings. The Department of Biology offers the opportunity for research in classical and molecular genetics, biochemistry and physiology of microorganisms. Opportunities are available for students wishing to prepare for independent scientific research in medical, industrial, and academic disciplines.

Microbiology Ph.D. students must demonstrate competence in their specific area of research and are expected to develop proficiency in at least four of the following broad areas: biochemistry/physiology, cell biology, genetics, immunology, applied microbiology and molecular biology. An M.S. student must demonstrate competence in at least three of the above six areas at the time of the final examination.

610. Immunology. (3-0). Credit 3. Overview of the field of immunology, emphasizing humoral and cellular immune mechanisms, immunoregulation, immunogenetics and the molecular biology of the immune response. Prerequisite: basic biochemistry or approval of instructor.

630. Protozoology. (3-3). Credit 4. Morphology, taxonomy, physiology, reproduction, phylogeny, ecology and life history of protozoa. Prerequisite: six hours of biology or approval of instructor.

635. Microbial Physiology. (3-0). Credit 3. Physiological activities of bacteria, metabolism, regulatory mechanisms, cell composition and use of 14C-substrates in physiology. Prerequisite: BICH 410 or 412.

647. Industrial Microbiology. (2-6). Credit 4. Bioassays of antibiotics, amino acids and vitamins, statistical design and analyses of dose-response assays. Fermentative production of overflow and secondary metabolites using stirred fermentors, and isolation of products. Screening soil isolates for capacity to degrade radioactively-labeled molecules and to produce antibiotics. BOD and bacterial analyses of wastewaters. Prerequisite: BICH 410 or 412.

651. Mycology. (2-6). Credit 4. Fungi; life cycles of representative forms, genetics and cytology, taxonomy, ecology. Prerequisite: MICR 353 or approval of instructor.

681. Seminar. (1-0). Credit 1. Detailed reports on specific topics in field chosen. Students may register in up to but no more than three sections of this course.

685. Problems. Credit 1 to 6 each semester. Limited investigations in fields other than those chosen for thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of microbiology.

690. Theory of Research. (3-0). Credit 3. Design of research experiments in zoology and the evaluation of research results with the aid of examples taken from the current scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

ZOOLOGY
(ZOOL)

The aims of a doctor of philosophy degree in zoology are to train the student to do original and significant research in zoological science, to develop a broad understanding of the zoological literature, and to provide experience and training in the presentation and publication of scientific findings. The Department of Biology offers special opportunities for animal research in several zoological subdisciplines. In addition, the broad range of biological sciences represented on campus permit collaborative programs in such areas a medicine, veterinary medicine, oceanography, and wildlife and fisheries sciences.

Zoology Ph.D. students must demonstrate competence in their specific area of research and are expected to develop proficiency in four of the following six areas: evolution/systematics, ecology/behavior, physiology/anatomy, biological mathematics, genetics/development and cellular/molecular biology. In addition, the student should have a thorough depth-of-knowledge of the organism or system used in the dissertation research. An M.S. student must demonstrate competence in at least three of the above six areas at the time of final examination.

605. Principles and Methods of Systematic Biology. (3-3). Credit 4. Evolutionary theory, subspecific variation, speciation and phylogeny; evolutionary, cladistical and numerical taxonomy, methods and rules used in viral, bacteriological, botanical and zoological classification.

606. Terrestrial Ecosystems. (3-3). Credit 4. Population and community structure and function in organization of terrestrial ecosystems, the world-wide pattern of major terrestrial ecosystems. Representative ecosystems studied in the field. Prerequisite: BIOL 357 or equivalent.

649. Comparative Endocrinology. (3-3). Credit 4. Function of endocrine glands and hormonal regulatory systems in different animal groups, vertebrates and invertebrates. Mechanisms of action of hormones at the cellular, subcellular and molecular level. Recent experimental advances in endocrinological research. Isolation, purification and assay of certain hormones and of enzymes involved in hormone metabolism. Prerequisite: course in physiology, BICH 410 or equivalent, or approval of instructor.

652. Human Physiological Response. (3-0). Credit 3. Function of human body in response to physical exertion and environmental stress. Systems of the body which are most affected by heavy exercises or man-made environment. Classroom demonstrations. Prerequisite: ZOOL 220 or 388 or approval of instructor.

653. Zoogeography. (3-0). Credit 3. Evolutionary, geological and ecological interpretations of the present and past distributions of terrestrial, freshwater and marine organisms.

660. Aquatic Ecology. (3-3). Credit 4. Primary and secondary productivity in lakes and streams, controlling factors, sampling and data analysis methodology; introduction to the construction and interpretation of computer models of aquatic systems. Previous modeling experience unnecessary.

662. Biology of Mollusca. (3-3). Credit 4. Survey of the phylum Mollusca, including systematics, identification of major groups to family, natural history, morphology, ecology and economic aspects. Prerequisite: ZOOL 335 or equivalent, or approval of instructor.

663. Biology of the Crustacea. (3-3). Credit 4. Classification, life history, morphology, physiology, ecology, diseases, parasites and predators of crustaceans. Economic aspects of crustaceans. Original literature emphasized. Prerequisite: ZOOL 335 or equivalent, or approval of instructor.

665. Biology of Invertebrates. (3-3). Credit 4. Morphology, biology and phylogeny of invertebrates. Topics may be either detailed discussions of specific organisms or comparative information on a process. Prerequisite: ZOOL 335 or equivalent.

666. Aerospace-Hydrospace Physiology. (3-0). Credit 3. Physiological systems most affected by changes experienced by the body both in aerospace and underwater existence. Overcoming physical hazards such as decompression, heat loss, fire, explosion. Methods of overcoming physiological limitation and requirements of life support systems. Prerequisite: approval of instructor.

681. Seminar. (1-0). Credit 1. Detailed reports on specific topics in field chosen. Students may register in up to but no more than three sections of this course.

685. Problems. Credit 1 to 6 each semester. Limited investigations in fields other than those chosen for thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of zoology.

690. Theory of Research. (3-0). Credit 3. Design of research experiments in microbiology and the evaluation of research results with the aid of examples taken from the current scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

BOTANY
(see Biology)

BUSINESS ADMINISTRATION
(BUAD)

620. Business Communication. (1-0). Credit 1. Techniques for effective use of oral and written communication in business. Written elements and applications; purposes, preparation sequences and delivery skills of oral presentations. Prerequisite: Approval of instructor. Cross-listed with ENGL 620. Classification 6 students may not enroll in this course.

625. Business Communications. (2-0). Credit 2. Focusing upon the process of designing written business communications, insight into the rhetorical strategies necessary for developing effective business communications. Prerequisite: Graduate classification in business administration. Classification 6 students may not enroll in this course. Cross-listed with ENGL 625.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of business administration. Prerequisite: Approval of instructor.

DEPARTMENT OF BUSINESS ANALYSIS AND RESEARCH

T. F. Anthony, R. L. Bregman, F. P. Buffa*, J. Choobineh, J. F. Courtney, Jr., R. A. Davis, J. J. Dinkel, E. B. Fliedner, B. E. Flores, G. C. Fowler (Interim Head), W. L. Fuerst, N. Gaither, R. W. Headrick, R. G. McLeod, Jr.**, D. L. Olson, D. B. Paradice, W. Rose, A. Sen, B. Shetty, W. E. Stein, M. J. Tretter, A. J. Vinze, D. W. Wichern

*Doctoral Student Advisor
**Master's Student Advisor

The Department of Business Analysis and Research offers graduate studies leading to M.S. and Ph.D. degrees and course work supporting the College of Business Administration's M.B.A. degree. These programs provide training for students interested in business computing science, production/operations management and management science.

The M.B.A. degree program consists of approximately 55 credit hours 12 of which are electives and may be taken in the department. Areas of course work include business computing science, production/operations management and management science.

The M.S. degree requires 36 credit hours (non-thesis option) or 32 credit hours (thesis option) and is designed for the student seeking specialization in business computing science. The degree program concentrates at least 24 hours of course work in management information systems and business computing science. Prerequisites for the M.S. degree include the AACSB common body of knowledge and knowledge of COBOL and one scientific programming language.

The Ph.D. program in business analysis allows the student to concentrate in management information systems, production/operations management or management science. The program's goal is to develop professionals who are well trained in the underlying theory and who have problem solving capabilities within the context of functional business areas. The program is research oriented and is comprised of a set of core courses dealing with current research in management information systems, production/operations management, management science and research methodology; advanced course work in the selected area of concentration; and dissertation research.

Additional information, including specific departmental requirements, may be obtained by contacting the department or the office of the dean, College of Business Administration.

(BANA)

603. Statistical Methods for Business. (3-0). Credit 3. Business trends and economic fluctuations; theory, causes and control of cyclical behavior; analytical forecasting. Basic business statistical techniques and applications. Classification 6 students may not enroll in this course. Prerequisite: MATH 230 or equivalent or approval of instructor.

605. Quantitative Analysis for Business Decisions. (3-0). Credit 3. Formulation and structuring of business problems using selected quantitative techniques. Investigation of prior research and formulation of specific problems. Classification 6 students may not enroll in this course. Prerequisite: BANA 603 or equivalent or approval of instructor.

607. Introduction to Business Computing. (3-0). Credit 3. An introduction to the broad field of computer applications tracing the development through the areas of electronic data processing (EDP), management information systems (MIS), decision support systems (DSS) and expert systems; user support, software development and hardware from micros to mainframes. Classification 6 students may not enroll in this course.

609. Operations Management. (3-0). Credit 3. Theory and applications of designing, analyzing and controlling productive systems in the allocation and use of productive resources to produce goods and services. Classification 6 students may not enroll in this course. Prerequisites: BANA 603, 605 and FINC 629 (or equivalents); graduate classification in College of Business Administration.

616. Business Programming Using COBOL. (3-0). Credit 3. Structure and techniques of the ANSI COBOL language applied to business featuring structured programming, file handling and sort packages. Design and implementation of business application programs. Prerequisite: BANA 617 or equivalent.

618. Assembly and COBOL Languages for Business Systems. (3-0). Credit 3. Internal functions and internal data representations of a digital computer presented through the medium of assembly language. Functions and representations used to illustrate the interaction of major software components and several advanced features of the COBOL programming language. Prerequisite: BANA 616 or equivalent or approval of instructor.

620. Systems Analysis for Business Data Processing. (3-0). Credit 3. Concepts of planning, developing, implementing and operating major business computer systems. Prerequisite: BANA 607 or equivalent.

622. Corporate Information Planning. (3-0). Credit 3. Concepts regarding the design and use of computer-based management information and decision support systems. Combinations of computing hardware and software and design concepts evaluated to meet managers' information needs. Prerequisite: BANA 620.

628. Information Management. (3-0). Credit 3. Information processing and management involving applications and user orientation in a business environment using commercially available information management packages. Prerequisite: BANA 616 or equivalent.

632. Business Computing Systems. (3-0). Credit 3. Theory and practice of the design and application of business systems in a mini or micro hardware environment. Prerequisites: BANA 620 and at least concurrent enrollment in BANA 622.

636. Decision Support Systems. (3-0). Credit 3. Use of decision support systems in business-related decision making, business environment, use of models, user interface with decision support systems and decision support systems examples. Prerequisite: BANA 605, ACCT 640 and FINC 629.

641. Theory and Research in Management Information Systems. (3-0). Credit 3. Theory, applications, and human and organizational issues of Management Information Systems (MIS); current academic research into the analysis, design, and implementation of computer information systems. Prerequisites: Ph.D. classification and approval of instructor.

651. Theory and Research in Management Science. (3-0). Credit 3. Theory, applications and computer implementation issues of management science; current research and practice in applying management science techniques in business; emphasis on deterministic and stochastic methods. Prerequisites: Ph.D. classification and approval of instructor.

658. Business Computer Models and Simulation. (3-0). Credit 3. Design and implementation of computerized decision models in the business organizational setting. Prerequisite: BANA 605.

664. Production and Operations Management. (3-0). Credit 3. Concepts, issues and techniques to plan, analyze and control systems of production; current research and practice in managing material systems and other elements of production. Prerequisites: STAT 652 or 601 and BANA 605 and permission of instructor.

684. Professional Internship. Credit 1 to 6. A directed internship in an organization to provide students with on-the-job training with professionals in organizational settings appropriate to the student's professional objectives. Prerequisite: Approval of committee chairman and department head.

685. Problems. Credit 1 to 4 each semester. Directed study on selected problems using recent developments in business research methods. Prerequisite: Approval of instructor.

688. Doctoral Seminar in . . . (3-0). Credit 3. Historical development of the conceptual framework of business analysis; evaluation of current research and controversial issues in management information systems, production/operations management, or management science. For doctoral students only. May be repeated for credit three times. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in identified area of business analysis. May be repeated for credit.

690. Theory of Research in Business Analysis. (3-0). Credit 3. Design of research in various subfields of business analysis and the evaluation of research results using examples from the current research literature. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

DEPARTMENT OF CHEMICAL ENGINEERING

A. Akgerman, R. G. Anthony, A. J. Appleby, D. B. Bukur, J. A. Bullin, R. Darby, R. R. Davison, L. D. Durbin, P. T. Eubank, R. W. Flumerfelt (Head), A. M. Gadalla, C. J. Glover, K. R. Hall, D. T. Hanson, W. B. Harris, C. D. Holland, J. C. Holste*, M. T. Holtzapple, T. R. Irvin, S. S. Koseoglu, K. N. Marsh, H. A. Preisig, S. Srinivasan, A. T. Watson, R. E. White

*Graduate Advisor

The Department of Chemical Engineering offers three graduate degrees: master of science, master of engineering (non-research) and doctor of philosophy. Also, the department offers courses and faculty supervision for students pursuing the doctor of engineering degree. A special program for B.S. degree holders in science or other engineering disciplines seeking a master's or a doctoral degree in chemical engineering is available.

The graduate program in chemical engineering provides students with well-rounded training in the fundamentals and research methods of the field. Specific departmental minimum requirements for course work and examinations are available from the department upon request.

Research is an integral part of the work leading to an advanced degree. Some areas of interest are thermodynamics, reaction engineering, distillation, electrochemistry, phase equilibria, biotechnology, extraction, process control, transport phenomena, rheology, environmental research, tertiary oil recovery, lignite liquefaction and

gasification, catalysis, mixing phenomena, mathematical models, polymer solution thermodynamics, methanol fuel, solar energy and biochemical energy (in cooperation with the Department of Agricultural Engineering). Modern equipment is available in numerous laboratories designed for one of the above specialties.

Further details about programs, faculty, facilities and financial aid are contained in an annual poster and a descriptive brochure is available by writing to the graduate advisor in the department.

(CHEN)

606. Unit Operations. (3-0). Credit 3. Applications of chemical engineering fundamentals in manufacture of chemicals, refining petroleum and other allied industries. Prerequisite: CHEN 424.

608. Heat Transmission. (3-0). Credit 3. Theoretical principles of conduction, radiation and forced convection; steady and unsteady state conduction problems with chemical reactions and phase changes. Boundary layer theory is stressed in connection with forced convection problems. Prerequisite: CHEN 323.

612. Distillation. (3-0). Credit 3. Process design calculations involving distillation of multicomponent and complex systems. Extractive and azeotropic distillation. Prerequisites: CHEN 409, 424.

613. Unsteady State Processes. (3-0). Credit 3. Formulation of exact models for, and solution of, corresponding equations for problems involving process equipment such as distillation columns, packed columns, evaporators and adsorption columns at unsteady state operation. Prerequisites: CHEN 606, 612.

619. Corrosion and Materials of Construction. (3-0). Credit 3. Fundamentals of corrosion and corrosion control. Electrochemical theory of corrosion processes, mixed potentials and corrosion rates. Corrosion resistance of metals and alloys, measurement of corrosion rates, anodic and cathodic control, and coatings. Prerequisites: CHEM 324; CHEN 354.

623. Applications of Thermodynamics to Chemical Engineering. (3-0). Credit 3. Application of thermodynamics to chemical engineering operations and processes. Prerequisite: CHEN 354.

624. Chemical Engineering Kinetics I. (3-0). Credit 3. Rates and mechanisms of chemical reactions. Thermal and catalytic reactions both homogeneous and heterogeneous. Prerequisite: CHEN 464.

625. Mass Transfer with Chemical Reaction. (3-0). Credit 3. Diffusion theories; equations of change for multicomponent systems; absorption with chemical reaction; slow, fast and instantaneous reaction regimes; laboratory absorbers; applications to packed towers and stirred vessels; special problems. Prerequisites: MATH 601 and 602.

629. Transport Phenomena. (3-0). Credit 3. Principles of transfer of momentum, energy and mass studied by application to advanced chemical engineering problems. Theoretical analogy of these three modes of transfer. Prerequisite: CHEN 424 or approval of instructor.

631. Process Dynamics I. (3-0). Credit 3. Dynamics, simulation and control of linear models of fluid, thermal and mass transfer processes for chemical industries by means of transient and frequency response analysis and design methods. Prerequisites: CHEN 461; MATH 601; or registration therein.

633. Theory of Mixtures. (3-0). Credit 3. Basic relations of statistical thermodynamics, intermolecular forces, liquid state, theory of mixtures, critical state, theory of conformal solutions, orientational effects, theorem of corresponding states, and applications to distillation and extraction. Prerequisite: CHEN 623 or CHEM 611.

634. Multiphase Reactors. (3-0). Credit 3. Laboratory reactors; mixing phenomena in multiphase reactors; tracer techniques in chemical reactor characterization; trickle bed reactors; two phase and three phase fluidized bed reactors; bubble columns; slurry reactors. Prerequisite: CHEN 624.

635. Process Modeling. (3-0). Credit 3. Formulation of mathematical models and solution of resulting mass and energy balance equations by modern computational techniques, applications to separation processes, chemical kinetics, reaction engineering, heat and mass transfer. Prerequisite: CHEN 606.

640. Rheology. (3-0). Credit 3. Principles of stress, deformation and flow; vector and tensor equations of fluid mechanics. Behavior of Newtonian, non-Newtonian and viscoelastic fluids. Prerequisite: MATH 601.

643. Applied Statistical Mechanics of Fluids. (3-0). Credit 3. Application of molecular theories and computer simulation techniques to describe the thermodynamics and transport properties of fluids and fluid mixtures. Prerequisite: CHEN 623.

650. Electrochemical Processes. (3-0). Credit 3. Fundamentals of reversible and irreversible electrode processes; energy conversion and electrochemical reactor design. Interaction between mass transport and kinetic mechanisms, industrial applications and corrosion. Prerequisite: CHEN 424 or approval of instructor.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology; application to the design, development and improvement of industrial processes that employ biological materials. Engineering discipline directed toward creative application of interdisciplinary information to the economic processing of biological and related materials. Prerequisite: Approval of instructors. Cross-listed with AGEN 651 and BIEN 651.

652. Biochemical Processing Technology. (3-0). Credit 3. Introduction for engineers to biochemistry, microbiology and genetic engineering; important processes in biotechnology such as enzymes, food, pharmaceuticals, waste treatment, fuels and chemicals, agricultural products and biotransformations. Prerequisite: AGEN 651 or CHEN 651. Cross-listed with AGEN 652.

653. Bioreactor Design. (3-0). Credit 3. Kinetics of enzyme reactions and cell growth applied to bioreactor design; media formulation, cell culture conditions, oxygen transfer, and sterilization. Prerequisite: CHEN 651/AGEN 651 or approval of instructor. Cross-listed with AGEN 653.

654. Separation Processes in Biochemical Engineering. (3-0). Credit 3. Theory and practice in isolation and purification of biological materials; properties of biological compounds; processing to retain biological activity of enzymes and other biomaterials; scale-up of separation processes; laboratory demonstrations of current technology. Prerequisite: CHEN 651. Cross-listed with AGEN 654.

661. Optimization of Chemical Engineering Processes. (3-0). Credit 3. Methods of optimization applied for the design and control of chemical engineering processes. Prerequisites: CHEN 606 or 613, CHEN 624, or approval of instructor.

681. Seminar. (1-0). Credit 1. Graduate students will be required to attend discussions covering problems of current importance in chemical engineering research.

685. Problems. Credit 1 to 6. One or more of numerous problems in chemical engineering processes and operations. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified areas of chemical engineering. May be repeated for credit. Prerequisites: Approval of department head and instructor.

691. Research. Credit 1 or more each semester. Problems of unit operations and unit processes. For maximum credit, comprehensive thesis must be prepared of sufficiently high calibre to permit publication in scientific and technical journals. Prerequisite: Approval of department head.

DEPARTMENT OF CHEMISTRY

E. T. Adams, D. H. R. Barton, D. E. Bergbreiter, J. W. Bevan, J. O'M. Bockris, L. S. Brown, A. Clearfield, D. L. Cocke, D. C. Conway, F. A. Cotton, D. J. Darensbourg, M. Y. Darensbourg, J. P. Fackler, Jr., K. A. Gingerich, D. W. Goodman, M. B. Hall (Head), K. E. Harding, J. F. Haw, E. E. Hazen, Jr.*, R. M. Hedges, C. A. J. Hoeve, J. L. Hogg, T. R. Hughbanks, K. J. Irgolic, J. Laane, P. A. Lindahl, T. M. Lohman, R. R. Lucchese, J. H. Lunsford, R. D. Macfarlane, A. E. Martell, C. R. Martin, W. E. McMullen III, E. A. Meyers, J. B. Natowitz, M. E. Newcomb, D. H. O'Brien, M. L. Peck, F. M. Raushel, A. S. Rodgers, M. P. Rosynek, M. W. Rowe, D. H. Russell, D. T. Sawyer, R. P. Schmitt, E. A. Schweikert, A. I. Scott, D. A. Singleton, M. P. Soriaga, Y.-N. Tang, G. Vigh, R. L. Watson, R. C. Wilhoit, K. L. Wolf, C.-H. Wong, D. L. Yeager, R. A. Zingaro, B. J. Zwolinski

*Graduate Advisor

Graduate work in chemistry is offered at both the master's and doctoral levels. The program leading to the master's degree is designed to provide the student with a strong fundamental knowledge and understanding in the major areas of chemistry. In addition, a thesis is required which affords the student an opportunity to actively participate in experimental or theoretical research.

The program leading to the Ph.D. degree is designed so that the student experiences extensive involvement in research. The dissertation which results from this research must satisfactorily demonstrate that the student is capable of independent and creative research in a specialized area of chemistry and has a superior knowledge and understanding of the area in which research activities were performed. In addition, the student must demonstrate that he or she has a broad and commanding knowledge of the subject matter in the general field of chemistry. The Department of Chemistry requires that each student participate in the teaching program of the department for at least two semesters as part of the M.S. or Ph.D. degree requirement. There is no language requirement at the M.S. level; the Ph.D. language requirement is determined by the student's Advisory Committee in order to meet individual needs related to research.

Opportunities for research are available to graduate students in the basic subfields of chemistry and in a variety of significant and relevant specialized areas. Faculty members are conducting continuing research programs and provide students with opportunities to make significant research contributions in modern physical, organic, inorganic, analytical and biological chemistry. There is also considerable departmental research activity in various interdisciplinary areas such as nuclear chemistry, theoretical chemistry, x-ray crystallography, electrochemistry, biophysical, bioorganic and bioinorganic chemistry. Five nuclear-related faculty, including four members of the Cyclotron Institute, provide one of the best graduate nuclear chemistry research programs available in this country. The department also offers strong research programs in heterogeneous and homogeneous catalysis, analytical instrumentation, coordination chemistry, high temperature chemistry, spectroscopy, physical photochemistry and organometallic chemistry.

Major scientific equipment required for modern chemical research is available in the department for the use of graduate students, including x-ray diffractometers; nmr, epr and photoelectron spectrometers; mass spectrometers; and infrared, Raman, ultraviolet, optical rotatory and circular dichroism spectrophotometers. A recent major addition to the Chemistry Building has brought the total space available for departmental instructional and research programs to more than 200,000 net sq. ft. For further details about programs, faculty, facilities and financial aid, write to M. B. Hall, head of the Department of Chemistry, for a descriptive brochure.

(CHEM)

601. Analytical Chemistry I. (3-0). Credit 3. Classical analytical chemistry: complex chemical equilibria, wet chemical methods of analysis and an introduction to electrochemical methods. Prerequisite: CHEM 317 or 620 or approval of instructor.

602. Analytical Chemistry II. (3-0). Credit 3. Modern analytical techniques: electrochemical, spectroscopic, chromatographic, thermal and trace methods of analysis. Prerequisite: CHEM 601.

606. Principles of Organic Chemistry. (3-0). Credit 3. General principles of organic chemistry and selected applications to other disciplines. Prerequisite: CHEM 228 or equivalent.

610. Organic Reactions. (3-0). Credit 3. Continuation of CHEM 646. Introduction to mechanisms and scope of the basic organic reaction types as applied to major functional groups. Prerequisite: CHEM 646.

611. Principles of Physical Chemistry. (3-0). Credit 3. General principles of chemistry from quantitative standpoint; thermodynamics and kinetics. Prerequisite: Graduate classification.

615. Organic Synthesis. (3-0). Credit 3. Application of organic reactions to synthesis of complex organic molecules. Synthesis design and methodology, scope and limitations of reactions, and experimental design. Prerequisite: CHEM 610.

618. NMR Spectroscopy. (3-0). Credit 3. Theory and practice of modern nuclear magnetic resonance spectroscopy; Bloch equations, relaxation and relaxation mechanisms, chemical exchange, pulse and Fourier-transform methods, selective excitation, 2-D methods, and solid-state nuclear magnetic resonance. Prerequisite: Graduate classification in chemistry or approval of instructor.

619. Analytical Spectroscopy. (3-0). Credit 3. Modern analytical spectroscopic techniques. U.V., visible spectroscopy, atomic absorption, emission spectrometry, flame emission, fluorometry, x-ray methods and other new developments in analytical spectroscopy. Prerequisite: CHEM 620 or approval of instructor.

620. Principles of Chemical Analysis. (3-0). Credit 3. Equilibria, including non-aqueous equilibria; the theoretical and practical aspects of modern instrumental methods of analyses. Prerequisite: Graduate classification in chemistry or approval of instructor.

621. Chemical Kinetics. (3-0). Credit 3. Present theories about chemical reaction rates and mechanisms. Prerequisite: CHEM 324.

622. Adsorption Phenomena and Heterogeneous Catalysis. (3-0). Credit 3. Chemistry of the gas-solid interface; energetics, isotherms and rates of gas adsorption on solid surfaces; experimental methods of studying solid surfaces and adsorption phenomena; kinetics and mechanisms of selected heterogeneous catalytic reactions.

623. Surface Chemistry. (3-0). Credit 3. Nature, structure and chemistry of surfaces; characterization of surfaces from surface energy to structure; relation to chemical processes. Prerequisite: Graduate classification in chemistry or approval of instructor.

626. Thermodynamics. (3-0). Credit 3. Theory and applications of classical thermodynamic functions. Prerequisite: CHEM 324.

627. Diffraction Methods. (3-0). Credit 3. Diffraction methods for determination of molecular structure. Results of diffraction of X-rays by crystals and other related methods. Prerequisites: CHEM 324; MATH 601 or equivalent; approval of instructor.

628. Coordination and Bioinorganic Chemistry. (3-0). Credit 3. Structure and reactivity of coordination compounds; reactions of metal ions with small biomolecules and the reactions of toxic metal ions; role of metal ions in biological systems including the function of metal ions in enzymes. Prerequisite: CHEM 633.

629. Main Group Chemistry. (3-0). Credit 3. Chemistry of the ns and np elements of the periodic table and the noble gases including the organometallic chemistry of these elements. Prerequisite: CHEM 633.

631. Statistical Thermodynamics. (3-0). Credit 3. Methods of statistical mechanics based primarily on Boltzmann statistics. Approach to thermodynamics through partition function. Statistical concept of entropy. Prerequisite: CHEM 626.

633. Principles of Inorganic Chemistry. (3-0). Credit 3. General principles of inorganic chemistry treated with a view to applications in other sub-fields of chemistry. Prerequisite: Graduate classification in chemistry or approval of instructor.

634. Physical Methods in Inorganic Chemistry. (3-0). Credit 3. Determination of the molecular structure of inorganic and organometallic species; modern aspects of diffraction, magnetic resonance and vibrational methods. Prerequisite: CHEM 641 or 673.

636. Mechanistic Inorganic Chemistry. (3-0). Credit 3. Reaction pathways in both main group and transition-metal complexes; factors which influence the reaction rate including nature of the metal, the coordination sphere, reaction conditions and catalytic intermediates. Prerequisite: CHEM 633.

637. Electroanalytical Chemistry. (3-0). Credit 3. Modern electroanalytical methods including potentiostatic, galvanostatic, sweep and periodic techniques. Prerequisite: CHEM 620 or approval of instructor.

641. Structural Inorganic Chemistry. (3-0). Credit 3. Introduction to chemical bonding; ionic, covalent, coordinate and hydrogen bonding; relationship of molecular orbital and ligand field theories to experimental studies of the electronic structure of inorganic molecules. Prerequisites: CHEM 633, 673.

642. Organometallic Chemistry and Homogeneous Catalysis. (3-0). Credit 3. Synthesis, structure and reactivity of organometallic compounds; elementary processes for general and radical reactions, mechanism of reactions at metal centers and applications to homogeneous catalysis. Prerequisite: CHEM 633.

645. Cluster Chemistry. (3-0). Credit 3. Nomenclature, structure, bonding, synthesis, reactions and catalysis of both main-group and transition-metal clusters. Prerequisite: CHEM 633.

646. Organic Chemistry. (3-0). Credit 3. A detailed introduction to the theory and principles of organic chemistry; bonding and structure in organic chemistry, stereochemistry, reactive intermediates in organic chemistry and transition state theory; kinetics and thermodynamic approaches. Prerequisite: CHEM 228 or approval of instructor.

647. Spectra of Organic Compounds. (3-0). Credit 3. Correlations of molecular structure with spectroscopic and other physical properties. Applications to modern problems in organic chemistry. Prerequisite: CHEM 646 or approval of instructor.

648. Principles of Quantum Mechanics. (3-0). Credit 3. Classical mechanics and development of wave mechanics. Application of wave mechanics to special chemical problems. Prerequisite: Approval of instructor.

649. Molecular Quantum Mechanics. (3-0). Credit 3. Continuation of CHEM 648. Introduction to group theoretical methods and applications in molecular quantum mechanics and elements of ligand field theory. Prerequisite: CHEM 648.

650. Molecular Spectra and Structure. (3-0). Credit 3. Introduction to molecular spectroscopy and its relations to structure, theoretical treatments, quantum and wave mechanics, vibrations and normal coordinates, molecular symmetry and group theory. Prerequisite: Qualifying graduate students in chemistry and physics or approval of instructor.

651. Recent Topics in Physical Chemistry. (2-0). Credit 2. Recent advances in such areas as surface chemistry and catalysis, properties of high molecular weight polymers and their solutions, photochemistry and theories of liquids and solutions. Prerequisites: CHEM 324 or equivalent; approval of instructor. The course may be taken for credit twice.

653. Recent Topics in Organic Chemistry. (2-0). Credit 2. Special topics of current interest in organic chemistry which are not normally covered in sufficient depth in other courses. Most subjects will be taken from recent or current chemical literature. Prerequisite: CHEM 646 or approval of instructor. The course may be taken for credit twice.

655. Polymer Science I. (3-0). Credit 3. Synthesis of polymers by condensation, addition and other types of polymerization. Solution methods of characterization. Solid state properties and their structural basis.

660. Nuclear Chemistry. (3-3). Credit 4. Radioactive decay, nuclear models, nuclear spectroscopy, nuclear reactions, fission and other topics of current interest in nuclear chemical research. Laboratory work to emphasize modern nuclear chemical instrumentation. Prerequisite: CHEM 464 or approval of instructor.

663. X-Ray Absorption and Emission in Analysis. (3-0). Credit 3. Fundamental knowledge of x-rays as applied to chemistry. Use of x-ray absorption, emission and diffraction in chemical analysis and control. Prerequisite: Approval of instructor.

665. Biophysical Chemistry. (3-0). Credit 3. The physical chemistry of macromolecules of biological importance. Methods applicable to solids and solutions, such as x-ray diffraction and scattering, osmometry, sedimentation equilibrium, electrophoresis and other thermodynamic and transport methods. Prerequisite: CHEM 324.

666. Nuclear Geochemistry. (3-0). Credit 3. Application of nuclear, chemical and physical principles for a better understanding of the origin of the solar system and the conditions acting upon it. Prerequisite: Bachelor's degree in science (chemistry, physics, geology, engineering, oceanography, etc.).

672. Bioorganic Reaction Mechanisms. (3-0). Credit 3. Proposed mechanisms of action of various enzymes and coenzymes from the "model systems" approach. New developments, theory and established mechanisms. Prerequisites: BICH 624 or CHEM 670; CHEM 646.

673. Symmetry and Group Theory in Chemistry. (2-0). Credit 2. Applications of symmetry and group theory to various types of chemical systems. Classification of molecules into symmetry point groups and use of character tables. Prerequisite: B.S. or B.A. in chemistry.

677. Nuclear and Radiochemical Methods of Analysis. (3-0). Credit 3. Theory and application of nuclear interactions; radioactivity and radiation in chemical analysis. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. Oral presentations and discussions of recent advances in chemistry.

685. Problems. Credit 1 to 6. Special topics to suit small group requirements. More recent problems and results in various branches of chemistry. Laboratory work or conference and discussion. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of chemistry. May be repeated for credit. Prerequisites: Graduate classification and approval of instructor.

690. Theory of Chemical Research. (3-0). Credit 3. The design of research experiments in various subfields of chemistry and the evaluation of research results with the aid of examples taken from the current scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

695. Frontiers in Chemical Research. (3-0). Credit 3. Present status of research in a variety of significant chemical fields. Content will depend on the availability of visiting lecturers who will be selected because of distinguished international recognition in their fields of research. May be taken twice. Prerequisite: Graduate classification.

DEPARTMENT OF CIVIL ENGINEERING

CIVIL ENGINEERING: R. L. Autenrieth, B. Batchelor, S. A. Batterman, W. L. Beason, J. S. Bonner, J.-L. Briaud, C. E. Buth, D. Y.-M. Chang, H. M. Coyle, C. L. Dudek, W. A. Dunlap, J. H. Earle, D. B. Fambro, J. E. Flipse, H. L. Furr, B. M. Gallaway, E. G. Garrison, C. P. Giammona, D. E. Hancher, R. W. Hann, Jr., W. J. Harris, Jr., J. B. Herbich, T. J. Hirsch, C. M. Hix, Jr., D. L. Ivey, M. E. James, Jr., R. W. James, W. P. James, H. L. Jones, P. B. Keating, C. H. Kim, T. L. Kohutek, R. A. Krammes, D. N. Little, Jr., Y. K. Lou, L. L. Lowery, Jr., M.-C. Lu, L. D. Lutes, R. L. Lytton, J. L. Machemehl, D. A. Maxwell, D. McDonald, C. J. Messer, J. R. Morgan, D. V. Morris, J. K. Nelson, Jr., J. M. Niedzwecki, J. S. Noel, R. E. Randall, T. D. Reynolds, E. J. Rhomberg*, P. N. Roschke, H. E. Ross, Jr., N. J. Rowan, T. G. Rozgonyi, C. H. Samson, Jr., D. R. Sanders, D. Saylak, R. A. Schapery, R. E. Schiller, Jr., R. E. Smith, W. H. Sprinsky, V. G. Stover, N. Stubbs, G. Stukhart, L. J. Thompson, J. T. Tielking, T. Urbanik II, J. B. Valdes, L. D. Webb, Y. Weitsman, J. J. A. Westerink, C. E. Woods, D. L. Woods, R. A. Wurbs, J. T. P. Yao (Head), J. Zhang

OCEAN ENGINEERING: J. E. Flipse, J. B. Herbich, Y. K. Lou (Program Head), J. L. Machemehl, J. M. Niedzwecki, R. E. Randall, J. J. A. Westerink

*Graduate Advisor

CIVIL ENGINEERING
(CVEN)

A variety of courses is offered in civil engineering to permit a student to study in a given branch. The department is especially well equipped to offer, with support from

other departments, areas of study in civil engineering systems; coastal and ocean engineering; construction engineering; cost engineering; environmental engineering; geodesy, photogrammetry and surveying; geotechnical engineering; hydraulic engineering and fluid mechanics; water resources engineering; materials engineering; public works engineering; structural engineering and structural mechanics; transportation engineering; urban management; and urban planning.

Modern facilities and current equipment are available to enhance study and instruction in engineering design graphics. These facilities include a graphics library, a reproduction and visual aid center, photographic and darkroom facilities, a computer graphics facility and special equipment.

No foreign language is required for the Ph.D. in civil engineering.

603. Water Quality in Lakes, Streams and Estuaries. (3-0). Credit 3. Physical, chemical, radiological and biological properties of streams, impoundments, reservoirs and estuaries, and the interrelationships of these properties; local, state, regional and federal water quality standards, legal aspects of water pollution control; quality criteria for beneficial uses of water; evaluation of critical problems. Prerequisite: Graduate classification in engineering or approval of instructor.

604. Introduction to Unit Operation Theory. (3-0). Credit 3. Introduction to the theory of various unit operations for water supply and waste water treatment; development of theoretical approaches to the design of various unit operations and criteria behind the development of the theoretical approach; fundamental principles of unit operations which are common to many systems; the evaluation of proto-type unit operations from laboratory data. Prerequisite: CVEN 402 or approval of instructor.

605. Experimental Analysis in Environmental Engineering. (1-6). Credit 3. Theory and practice of analytical methods used in the environmental engineering field. Instrumental and wet chemical techniques used in measurement of environmental quality parameters and pollutants. Prerequisite: Graduate classification in engineering or approval of instructor.

606. Design of Waste Water Treatment Systems. (1-6). Credit 3. Application of the theories of unit operations and unit processes to design waste water treatment systems for domestic and industrial wastes. Prerequisites: CVEN 603, 604 or approval of instructor.

607. Engineering Aspects of Air Quality. (3-0). Credit 3. Characterization of air contaminants. Health effects and legal aspects. Dispersion of pollutants in the atmosphere. Technology for the control of gaseous and particulate emissions. Prerequisite: CVEN 311.

608. Solid Waste Engineering. (2-3). Credit 3. Design and operation of solid waste collection and disposal systems. Review of appropriate state and federal regulations. Prerequisite: Approval of instructor. Prerequisite: CVEN 338, 365 or equivalent.

609. Environmental Control of Oil and Hazardous Materials. (2-3). Credit 3. Oil and hazardous material (OHM) spills in the engineering design process; evaluation of OHM properties and their behavior on and impact to environmental systems; prevention programs and documents, technology for spill containment and removal; contingency planning cycle including administrative site-specific plans and resource acquisition; response organization; restoration and documentation. Prerequisite: Bachelor's degree in science or engineering.

610. Industrial Wastes. (2-3). Credit 3. Theory of industrial processes which create industrial wastes. Effect of industrial wastes on treatment processes. Process recovery units to prevent pollution and effluent waste treatment practices. Prerequisites: CVEN 603, 605, or approval of instructor.

611. Design of Potable and Industrial Water Systems. (1-6). Credit 3. Application of theories of unit operations and unit processes to the design of systems for treatment of water for domestic and industrial uses. Prerequisites: CVEN 603, 604, or approval of instructor.

612. Transportation in City Planning. (2-3). Credit 3. Influence of transportation in shaping urban form; relationships between land use and transportation; conceptual layout of street systems. Trends in urban development; site development; circulation and relationships to the street system. Guidelines for the redevelopment of existing streets and the adjacent land. Cross-listed with PLAN 612.

613. Urban Engineering. (3-0). Credit 3. Service course for nonengineers on influence and relative importance of engineering aspects of urban development; engineering factors important in consideration of utilities, land allocation, waste disposal, drainage, public health and recreation.

614. Stabilization of Soil-Aggregate Systems. (2-0). Credit 2. Theory of mechanical and chemical stabilization of soils and soil-aggregate systems.

615. Structural Design of Pavements. (3-0). Credit 3. Characteristics of pavement loads, stress analysis in pavements, design practices, construction, rehabilitation and maintenance. Prerequisite: CVEN 307.

616. Systems Design of Pavements. (2-3). Credit 3. Optimization of the design of rigid and flexible pavement systems. Empirical and mechanistic stochastic structural subsystems. Utility theory, serviceability concept, cost studies, traffic delay, environmental deterioration, rehabilitation and maintenance optimization systems. Prerequisite: CVEN 307.

617. Traffic Engineering: Characteristics. (2-3). Credit 3. Human, vehicular and traffic characteristics as they relate to driver-vehicle-roadway operational systems. Traffic studies and methods of analysis and evaluation. Prerequisite: CVEN 457 or equivalent.

618. Traffic Engineering: Operations. (2-3). Credit 3. Advanced theory and application of traffic control. Signalization and freeway operations. Prerequisite: CVEN 457 or equivalent.

621. Advanced Reinforced Concrete Design. (3-0). Credit 3. Reinforced concrete principles; analysis of rigid building frames, design of building frames, slabs, biaxially loaded columns, rectangular and circular tanks, and deep beams. Prerequisite: CVEN 344 or equivalent.

622. Properties of Concrete. (3-0). Credit 3. Materials, properties and behavior of concrete; cement, cement types, aggregate characteristics; properties of fresh concrete; structure of portland cement paste; mechanical properties of hardened concrete; durability and repair of concrete structures. Prerequisites: CVEN 321 and 343.

623. Concrete Construction Engineering. (3-0). Credit 3. Engineering properties of aggregate, cements and concrete. Special cements, mix design, construction practices, pumping, quality control, lightweight concrete strength, curing, volume change and ready-mixed concrete. Prerequisite: Approval of instructor.

626. Roadside Safety Design. (3-0). Credit 3. Fundamental concepts of designing safety into roadways. Safety improvement programs, accident data analysis, safety methodology, safety in cross section design and the design of safety devices. Safety improvement programs, sideslopes and ditches, breakaway devices, crash cushions and roadside barriers.

627. Surface Water Hydrology. (3-0). Credit 3. Precipitation-runoff processes; watershed and streamflow modeling; frequency analysis; erosion and sedimentation; hydrologic design of hydraulic structures and nonstructural stormwater management strategies. Prerequisite: Approval of instructor.

628. Advanced Hydraulic Engineering. (2-3). Credit 3. Newton Raphson pipe network analysis, unsteady flow in pipelines and pipe networks; method of characteristics; river engineering; two-dimensional streamflow modeling; design of hydraulic stuctures. Prerequisite: CVEN 458 or approval of instructor.

629. Hydraulics of Open Channels. (3-0). Credit 3. Application of momentum and energy principles to advanced topics in uniform, nonuniform, gradually varied and rapidly varied flow problems. Backwater flow profile computation in steady flow. The method of characteristics applied to unsteady flows. Jeffreys-Vedernikov criteria. Flood routing calculations by advanced computer methods. Prerequisite: Approval of instructor.

630. Applications of Construction Law. (3-0). Credit 3. Analysis of construction law and the construction process; legal problems in the bidding process and in the performance of the contract. Prerequisite: COSC 479 or approval of instructor. Cross-listed with COSC 628.

631. Industrial Construction. (3-0). Credit 3. Planning, project management and construction management of large industrial construction projects; planning procedures of clients for new construction; functions of project management and construction management teams; construction operations associated with power plant, process plant or other industrial construction. Prerequisite: Graduate classification in engineering or building construction.

632. Street and Highway Systems Management. (2-0). Credit 2. Street classification and function; obtaining the maximum potential from the surface street system and basic design criteria for city streets; transportation systems management of the urban system. Prerequisite: Graduation classification in engineering or urban and regional planning or approval of instructor.

633. Advanced Mechanics of Materials. (4-0). Credit 4. Stresses and strains at a point, torsion of noncircular cross sections, beams with combined axial and lateral loads, energy methods, thick walled pressure vessels, theories of failure, introduction to the theory of elasticity, theory of plates, theory of elastic stability and solution to elementary problems. Prerequisites: AERO 306 or CVEN 306; MATH 308 or approval of instructor.

634. Airport Planning and Design. (2-2). Credit 3. Planning and design of the airfield; functional terminal configurations and adjacent area land use problems. Airport location, runway orientation, runway capacity, surface drainage, runway pavement design, terminal orientation and ground access considerations.

635. Street and Highway Design. (3-3). Credit 4. Advanced concepts of the design of streets and highways, design criteria, controls and standards for design alignment, cross section, intersections and interchanges and environmental impacts of surface transport facilities. Prerequisite: CVEN 456 or equivalent.

639. Methods Improvement for Construction Managers. (3-0). Credit 3. Application of work methods and measurements to construction; examination of factors that affect productivity in construction; study of motivational factors; review of the principles of accident prevention. Prerequisite: CVEN 473 or approval of instructor.

640. Heavy and Civil Works Construction. (3-0). Credit 3. Application of geotechnics, engineering design and the construction arts to the design and evaluation of systems for construction of heavy and civil works. Prerequisite: CVEN 473 or approval of instructor.

641. Construction Engineering Systems. (3-2). Credit 4. Application of systems theory to project planning and control; probabilistic network diagramming, resource allocation, statistical bidding analysis, activity planning, financial management of construction projects and project control. Prerequisite: CVEN 473 or approval of instructor.

642. Construction Engineering Management. (3-0). Credit 3. Construction planning, organization, coordination and direction, feasibility, contract specifications, risk, liability, quality; role of the owner, engineer and contractor; contract performance problems. Prerequisite: CVEN 473 or approval of instructor.

643. Plastic Analysis and Design in Steel. (3-0). Credit 3. Principles and methods that are basis for plastic analysis and design. Static and mechanism methods of analysis of structures. Influence of shear and axial forces on plastic design. Effect of lateral buckling. Design of connections to provide plastic action. Prerequisite: Graduate classification in civil engineering or approval of instructor.

644. Rock Mechanics. (3-0). Credit 3. Deformation, strength and fluid-flow properties of intact rock and rock masses with applications to underground openings, rock slopes and dam foundations and abutments. Methods of rock-mass exploration and characterization; techniques of laboratory and *in situ* field measurements in rock; theoretical analysis and model studies; design considerations and excavation methods; selected case histories. Prerequisite: Approval of instructor.

645. Geotechnical Site Investigation. (2-0). Credit 2. Soil sampling techniques to obtain disturbed and undisturbed samples; in situ field tests including standard penetration test, cone penetration test, vane test, pressuremeter test and their use in practice; other recent advances in sampling, in situ testing and site investigation both onshore and offshore. Prerequisite: CVEN 365, 435 or equivalent.

646. Foundations on Expansive Soils. (3-0). Credit 3. Properties of partially saturated soils, analysis of beams and plates on foundations, slab-subgrade friction, design of slabs and drilled piers, soil improvement techniques, risk analysis and foundation rehabilitation operations. Prerequisites: CVEN 365, MATH 308 or approval of instructor.

647. Numerical Methods in Geotechnical Engineering. (2-2). Credit 3. Formulation and application of finite element and discrete element methods in solving geotechnical engineering problems related to seepage, diffusion, elasticity, plasticity, fracture and dynamic motion of soil masses, stability and convergence problems and use of existing computer programs in working applied problems. Prerequisite: Degree in engineering or approval of instructor.

648. Design and Analysis of Earth Structures. (2-0). Credit 2. Principles of design and stability analysis applied to earth and rock-filled dams, embankments, natural slopes and cuts. Types of dam cross sections and selection criteria. Prediction of pore pressures during and after construction. Stability calculations. Total and effective stress methods. Initial and long-term stability. Prerequisites: AERO 320 or equivalent; CVEN 650 or registration therein.

649. Physical and Engineering Properties of Soil. (3-3). Credit 4. Introduction to physicochemical properties of soils; soil structure; soil classification; permeability; principle of effective stress; stress-deformation and strength characteristics; partly saturated soils; testing procedures. Prerequisites: CVEN 365, 435 or approval of instructor.

650. Seepage and Consolidation. (2-3). Credit 3. Fundamentals of groundwater flow; flow under and through earth structures using flow nets; closed form solutions; numerical and approximate methods; dewatering systems; advanced theory of consolidation; numerical methods in consolidation; design of sand drains. Prerequisite: CVEN 649.

651. Theoretical Soil Mechanics. (2-3). Credit 3. Fundamentals of mechanics of deformable bodies; theory and application of elasticity, plasticity, viscoelasticity and approximate rheological models to soil mechanics problems. Prerequisite: Approval of instructor.

652. Soil Dynamics. (3-0). Credit 3. Dynamic properties of soil; wave propagation in an elastic medium. Analysis of dynamic soil-structure interaction and machine foundations. Earthquake engineering; soil liquefaction; seismic design of foundations, dams, retaining walls and pipelines. Prerequisite: MATH 308.

653. Bituminous Materials. (2-3). Credit 3. Production, specifications and tests of bituminous materials; design and evaluation of asphaltic concrete for construction and maintenance; inspection control of street, parking and highway paving surfaces. Prerequisite: Graduate classification in engineering.

655. Structural Reliability. (3-0). Credit 3. Uncertainties in structural mechanics; probabilistic models for load and resistance variables, fundamentals of structural reliability theory, advanced first-order second moment methods and reliability of complex structural systems; applications to selected structures. Prerequisites: CVEN 345 and 383.

657. Dynamic Loads and Structural Behavior. (3-0). Credit 3. Forces resulting from wind, other moving fluids, earthquake, blasts, impact, moving loads and machinery. Dynamic behavior of various structures and structural elements under action of such loads. Self-induced vibration. Prerequisites: MATH 308; MEMA 467, or approval of instructor.

658. Earthquake Engineering. (3-0). Credit 3. Characteristics of earthquakes; response of structures to earthquake ground motions; behavior of materials, elements, assemblages and structures subjected to earthquakes; principles of earthquake resistant design. Prerequisite: CVEN 657.

659. Behavior and Design of Steel Structures. (3-0). Credit 3. Buckling and post-buckling strength of stiffened and unstiffened plate elements; behavior and design of light-gage steel structures and plate girders; stability of frames; frames subject to sidesway; bracing design; non-destructive evaluation of welded structures. Prerequisite: CVEN 346 or approval of instructor.

661. Photo Interpretation. (2-2). Credit 3. Photographic processes related to interpretation; principles, methods and techniques of photo interpretation; applications in soils, engineering materials, geology, geomorphology, water resources, transportation and urban planning. Prerequisite: Approval of instructor. Cross-listed with FRSC 661.

664. Water Resources Planning and Management. (3-0). Credit 3. Technological and institutional approaches for managing water resources; the planning process; systems analysis methods; comprehensive integration of engineering, economic, environmental, legal and political considerations in water resources development and management; issues and future directions. Prerequisite: Approval of instructor.

665. Water Resources Systems Engineering. (3-0). Credit 3. Linear and non-linear optimization models and simulation models for planning and management of water systems; single- and multi-objective analysis and deterministic and stochastic techniques. Prerequisites: CVEN 338 and 384 or equivalent.

666. Foundation Structures. (3-0). Credit 3. Geological and soil mechanics principles: load bearing capacity, soil pressure and settlement. Design of shallow foundation sub-structures: pedestals, spread footings, combined footings, mats and underream footings. Design of deep foundations: piles and drilled piers. Retaining walls, cofferdams and sheet piles.

672. Urban Transportation Study. (3-3). Credit 4. Procedures and techniques of traditional urban transportation studies. Study design, data collection and processing, trip generation, trip distribution, traffic assignment and mode choice. Data reliability; sketch planning and abbreviated study techniques. Cross-listed with PLAN 672.

674. Groundwater Hydrology and Hydraulics. (3-0). Credit 3. Groundwater hydrology, theory of groundwater movement, steady state flow, potential flow, flow nets, mechanics of well flow, multiple-phase flow, salt water intrusion, artificial recharge, legal aspects and models. Prerequisite: CVEN 311 or approval of instructor.

678. Hydromechanics. (3-0). Credit 3. General conservation laws; Euler's equation, forms of the Bernoulli's equation; potential flow of an incompressible fluid; flow past a body of any shape; source and vortex distribution; lift for a slender body; linear and nonlinear water waves; small amplitude oscillations in a compressible ideal fluid or viscous flow theory. Prerequisite: CVEN 462 or approval of instructor. Cross-listed with OCEN 678.

679. Theory of Fluid Mechanics Models. (3-0). Credit 3. Dimensional analysis; model laws; mathematical techniques; applications to fluid mechanics and coastal engineering models; fixed-bed; movable-bed, geometric and distorted models for flows with free surface; sediment transport; waves, tides and estuary models. Prerequisite: Approval of instructor.

681. Seminar. (0-2). Credit 1. Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program and twice in Ph.D. program.

685. Problems. Credit 1 to 6 each semester. Enables majors in civil engineering to undertake and complete with credit in their particular fields of specialization limited investigations not within their thesis research and not covered by other courses in established curriculum.

686. Offshore and Coastal Structures. (3-0). Credit 3. Fundamental design and analysis techniques; offshore platform analysis by computer (STRUDL, STRAN), pile driving analysis of large offshore piles by the wave equation, finite element analysis of underwater shells of revolution. Solutions to problems submitted by industry to the class during the semester. Prerequisite: Approval of instructor. Cross-listed with OCEN 686.

687. Marine Foundation Engineering. (2-2). Credit 3. Foundation engineering problems associated with a marine environment. Settlement and bearing capacity analysis of nearshore and offshore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles and sheet-pile walls. Prerequisites: CVEN 365; approval of instructor. Cross-listed with OCEN 687.

688. Computational Fluid Dynamics. (3-0). Credit 3. Finite-difference and finite-element methods and basic numerical concepts for the solution of dispersion, propagation and equilibrium problems commonly encountered in real fluid flows. Theoretical accuracy analysis techniques. Prerequisites: Undergraduate course in fluid mechanics; MATH 601 and/or basic course in linear algebra; knowledge of one programming language.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of civil engineering. May be repeated for credit. Prerequisites: Approval of instructor and of department head.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

The following MEMA courses (Mechanics and Materials found in the Interdisciplinary Engineering section) are part of the curriculum in civil engineering.

601. Theory of Elasticity. (3-0). Credit 3.
603. Foundations of Solid Mechanics. (3-0). Credit 3.
605. Energy Methods. (3-0). Credit 3.
607. Flow and Fracture of Solids. (3-0). Credit 3.
608. Elasticity of Structural Elements. (3-0). Credit 3.
609. Materials Science. (3-0). Credit 3.
613. Principles of Composite Materials. (3-0). Credit 3.
618. Designing with Composites. (2-3). Credit 3.
620. Processing and Testing of Composite Materials. (2-3). Credit 3.
632. Structural Stability. (3-0). Credit 3.
633. Theory of Plates and Shells. (3-0). Credit 3.
636. Theory of Thermal Stresses. (3-0). Credit 3.
640. Theory of Shells. (3-0). Credit 3.
641. Plasticity Theory. (3-0). Credit 3.
647. Theory of Finite Element Analysis. (3-0). Credit 3.
650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3.
651. Viscoelasticity of Solids and Structures I. (3-0). Credit 3.
652. Viscoelasticity of Solids and Structures II. (3-0). Credit 3.
689. Special Topics in . . . Credit 1 to 4.

OCEAN ENGINEERING
(OCEN)

The graduate program in ocean engineering is broad-based and is designed to fit the needs of graduates from most engineering disciplines as well as naval architecture graduates. An ocean engineer must know about the ocean environment and its measurable parameters; the behavior of materials within the ocean environment; the transfer of communication characteristics of the ocean; and operational, instrumentation and other hardware capabilities within the ocean.

Some of the specialization areas within ocean engineering include coastal and ocean structures, marine engineering and naval architecture, instrumentation and communications in the ocean, wave and storm prediction, offshore pipelines design, coastal sediment processes and dredging.

No foreign language is required for the Ph.D. in ocean engineering.

620. Arctic Offshore Engineering. (3-0). Credit 3. Arctic and sub-arctic cold regions engineering; ice mechanics, sea ice formation, material properties and ice forces; limit load concepts, probabilistic methods, offshore structures; islands, mobile and fixed platforms, new concepts and optimal design. Prerequisite: MEMA 467.

630. Dynamics of Ocean Vehicles. (3-0). Credit 3. Dynamics and stability of motion of immersed and floating structures and ocean vehicles. Maneuverability and control. Behavior of ocean vehicles and stationary platforms in waves. Design considerations leading to motion reduction. Applications to surface vessels, submersibles and drilling rigs. Prerequisites: CVEN 311, MEEN 459 or equivalent, or approval of instructor.

666. Principles of Geodynamics. (4-0). Credit 4. Geological and geophysical methods and phenomena pertinent to geodynamics. Plate tectonics; seismicity and seismology; magnetics; gravity; heat flow; igneous, metamorphic and sedimentary petrology; paleontology; and rock mechanics. Prerequisite: Approval of instructor. Cross-listed with GEOL 666 and GEOP 666.

671. Ocean Wave Mechanics. (3-0). Credit 3. Wave theory and applications to engineering problems; linear and non-linear theories of regular gravity waves; wave properties and transformation in shoaling water; spectral analysis of irregular waves; forecasting, hindcasting and theoretical spectra. Prerequisite: OCEN 462 or equivalent.

672. Coastal Engineering. (3-0). Credit 3. Effects of waves on coastal structures; design of seawall breakwaters, jetties, harbors, ship channels and pipelines; intentional and accidental discharge of pollutants; diffusion and spreading; oil spill containment and collection. Prerequisite: OCEN 671.

676. Dynamics of Offshore Structures. (3-0). Credit 3. Review of concepts of linear structural dynamic analysis for time and frequency domain simulations, functional design of offshore platforms, pipelines, floating structures and moorings. Environmental loading problems. Hydrodynamic phenomena including wind and current interaction, vortex shedding and wave forces; structure-fluid interaction models. Prerequisites: OCEN 300, 301, or approval of the instructor.

678. Hydromechanics. (3-0). Credit 3. General conservation laws; Euler's equation, forms of the Bernoulli's equation; potential flow of an incompressible fluid; flow past a body of any shape; source and vortex distribution; lift for a slender body; linear and nonlinear water waves; small amplitude oscillations in a compressible ideal fluid or viscous flow theory. Prerequisite: CVEN 462 or approval of instructor. Cross-listed with CVEN 678.

681. Seminar. (0-2). Credit 1. Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program and twice in Ph.D. program.

682. Coastal Sediment Processes. (3-0). Credit 3. Sediment properties and size distribution, fluvial sediment transport equations, movement of material by the sea, review of pertinent wave theories, littoral drift, inlet stability, coastal protection structures, similarity in sediment transport, movable bed models, sediment tracing, Aeolian sand transport, case studies. Prerequisite: Approval of instructor.

683. Estuary Hydrodynamics. (3-0). Credit 3. Development of applicable equations for tidal dynamics applied to real estuaries. Technology for determination of mean velocities, circulation patterns, water depths, turbulent dispersion patterns, etc. for solution of environmental problems in estuaries. Physical and mathematical models. Prerequisites: Basic fluid mechanics; approval of instructor.

685. Problems. Credit 1 to 6 each semester. Special topics not within scope of thesis research and not covered by other formal courses.

686. Offshore and Coastal Structures. (3-0). Credit 3. Fundamental design and analysis techniques; offshore platform analysis by computer (STRUDL, STRAN), pile driving analysis of large offshore piles by the wave equation, finite element analysis of underwater shells of revolution. Solutions to problems submitted by industry to the class during the semester. Prerequisite: Approval of instructor. Cross-listed with CVEN 686.

687. Marine Foundation Engineering. (2-2). Credit 3. Foundation engineering problems associated with a marine environment. Settlement and bearing capacity analysis of nearshore and offshore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles and sheet-pile walls. Prerequisites: CVEN 365; approval of instructor. Cross-listed with CVEN 687.

688. Marine Dredging. (3-0). Credit 3. Dredge pump selection; pump and system characteristics; cavitation; types of dredges; continental shelf and deep-ocean dredging; head loss in horizontal and vertical pipes for two and three-phase flow; design of disposal methods for dredged material; environmental effects of dredging. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of ocean engineering. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

DEPARTMENT OF COMPUTER SCIENCE

J. Abello, C. Boyle, S. B. Childs, D. Colunga, D. K. Friesen, D. Gordon, H. J. Hernandez-Lopez, J. L. Kim, J. J. Leggett, W. M. Lively, F. Lombardi, B. H. McCormick, A. Mukerjee, U. W. Pooch, S. V. Sheppard, D. B. Simmons*, R. A. Volz (Head), G. N. Williams, J. D. Wolter

*Graduate Advisor

The Department of Computer Science offers graduate studies leading to the degrees of master of computer science, master of science in computer science and doctor of philosophy.

Advanced study in computer science is designed to provide the skills to design and utilize modern computer systems. The field of computer science is rapidly changing and expanding, generating a need for computer scientists in the burgeoning industry. The Computer Science Department is meeting these needs with advanced study in computer science.

Areas of study in computer science include theoretical computer science, artificial intelligence and cognitive modelling, computer vision, graphics and robotics, computational mathematics and simulation, computer systems and networks, software systems, and VLSI design automation.

Special laboratory facilities are available to graduate students in artificial intelligence, software engineering, graphics, robotics, computer vision, distributed processing and databases. The department houses several super minicomputers and a network of microcomputer systems for individual student use.

There is no foreign language requirement for the Ph.D. programs in computer science.

(CPSC)

604. Programming Language Design. (3-0). Credit 3. Research topics in high level languages including: data abstraction, generics, tasking, exception handling, parallelism and concurrency; advanced specification techniques for syntax and semantics of programming languages; alternative language designs; imperative, functional, descriptive, object oriented and data flow; overview of implementation and use of high level languages; language interface with support environments. Prerequisite: CPSC 432.

605. Compiler Design. (3-0). Credit 3. Advanced topics in compiler writing; parser generators and compiler-compilers; dynamic storage and scope resolution; data flow analysis and code optimization. Prerequisite: CPSC 434.

606. Software Engineering. (3-0). Credit 3. Development of advanced concepts in software engineering; software development environments as a mechanism for enhancing productivity and software quality; the classification, evaluation and selection of methodologies for environments; rapid prototyping and reusability concepts; artificial intelligence techniques applied to software engineering; transformational systems; maintenance environments. Prerequisite: CPSC 431.

607. Software Models and Metrics. (3-0). Credit 3. Software models and metrics; productivity predicting techniques; complexity measures; software reliability models; cost estimation models. Prerequisite: CPSC 431.

608. Database Systems. (3-0). Credit 3. Review of basic database models; concepts in database systems including knowledge representation and knowledge based systems; database architectures, networks and distributed databases; database design and performance measurements; query languages and natural language interfaces. Prerequisite: CPSC 310.

609. Artificial Intelligence Approaches to Software Engineering. (3-0). Credit 3. Artificial Intelligence techniques and approaches to software engineering; revolutionary paradigms and automatic programming; the knowledge-based assistant in management, specification capture, prototyping and maintenance; transformational systems and reuseable libraries; AI tools for software development; graphical approaches to software engineering. Prerequisites: CPSC 606 and 625.

610. Hypertext/Hypermedia Systems. (3-0). Credit 3. Comprehensive coverage of Hypertext/Hypermedia; concepts and definitions; fundamental components, architectures and models; problems and current solutions; design and implementation issues; and research issues. Prerequisites: CPSC 310 and 410.

613. Operating Systems. (3-0). Credit 3. Analysis of algorithms in computer operating systems; sequencing and control algorithms supporting concurrent processes; scheduling algorithms to minimize execution times and mean flow times; algorithms for allocating tasks to processors. Prerequisite: CPSC 410.

614. Computer Architecture. (3-0). Credit 3. Reviews von Neumann architecture and its limitations; concepts of parallel computer structures and concurrent computation; analysis of pipeline computers, array processor machines and multiprocessor systems; control models for control-driven, data-driven and demand-driven machines. Discussion and analysis of intelligent interfaces, inference machines and knowledge-based systems. Prerequisite: CPSC 321.

616. Computer Systems Performance. (3-0). Credit 3. Tools and techniques used to measure performance of computer and network systems; evaluation studies: monitoring techniques, modeling methods and model validation; techniques of analytic and simulation modeling and their comparison; case studies of several distributed and network system configurations. Prerequisites: CPSC 410 and 461.

617. Advanced Data Communication Networks. (3-0). Credit 3. Advanced concepts and analysis of control of data and computer communication networks; develops and studies analytically communication network models, optimal and adaptive routing, optimal quasi-static routing methods, dynamic routing, multi-access schemes, local networks, packet radio networks and flow control algorithms. Prerequisite: ELEN 602 or CPSC 619. Cross-listed with ELEN 617.

618. Resilient Computer Systems. (3-0). Credit 3. Impact of reliability on computer and network system design; stochastic models of reliability and availability in fault-tolerant systems; system reorganization and self-repair; analysis of systems capable of non-stop processing in response to environmental changes, varying functional requirements and user needs. Prerequisite: CPSC 410.

619. Networks and Distributed Computing. (3-0). Credit 3. Computer network concepts including network architecture, layering, protocols, packet switching and virtual circuits; performance evaluation and design considerations for local area networks; packet distributed networks; satellite networks; distributive processing including array, parallel and multiprocesor systems. Prerequisites: CPSC 410 and 463.

625. Artificial Intelligence. (3-0). Credit 3. Concepts and methods of artificial intelligence. Properties of single-goal decision-making systems. Decision-making under certainty, uncertainty and under risk. Prediction, learning and adaption. Self-organizing systems. Single-level, multi-goal systems. Formal theory of game playing and teams. Multi-level, multi-goal (hierarchical) systems and organization. Prerequisites: CPSC 203, 204.

626. Parallel Algorithm Design and Analysis. (3-0). Credit 3. Design of algorithms for use on highly parallel machines; area-time complexity of problems and general lower bound theory; application (of these concepts) to artificial intelligence, computer vision and VLSI design automation. Prerequisite: CPSC 311.

627. Theory of Computability. (3-0). Credit 3. Formal models of computation such as pushdown automata, Turing machines and recursive functions; unsolvability results; complexity of solvable results. Prerequisite: CPSC 311.

629. Analysis of Algorithms. (3-0). Credit 3. Concrete algorithm design and analysis; abstract models to analyze the complexity of problems; NP-Completeness; approximation and probabilistic algorithms. Prerequisite: CPSC 311.

631. Programming Environments for Artificial Intelligence. (2-2). Credit 3. Languages used in artificial intelligence with emphasis on LISP and PROLOG; environments for programming in these languages; practice using these environments in the solution of artificial intelligence problems. Prerequisite: CPSC 320 or 625.

632. Expert Systems. (2-2). Credit 3. Basic concepts for building expert systems; architecture of expert systems; the knowledge acquisition process; languages and tools for building expert systems; evaluation of expert systems; issues and case studies; practice in the design and evaluation of expert systems. Prerequisite: CPSC 320 or 625.

633. Machine Learning. (3-0). Credit 3. Machine learning from an artificial intelligence perspective; learning strategies for problem solving; the role of analogy in problem solving and the process of drawing analogies by derivational transformations; learning concepts and rules from examples; learning from observation and discovery; cognitive modeling and language learning. Prerequisite: CPSC 320 or 625.

634. Speech Generation and Understanding. (2-2). Credit 3. A knowledge-based approach to morphologic speech recognition and generation; rules for combining uncertain connected phoneme streams into words; rejection of unreasonable words by syntactic, semantic and discourse hypothesis testing; rule-based speech generation; specialized architectures, analytic techniques, languages and programming environments for speech research. Prerequisite: CPSC 320 or 625.

635. Natural Language Processing. (3-0). Credit 3. A procedural logic approach to the representation of natural language for computational uses such as translating text, commanding robot actions, intelligent database retrieval and expert systems; emphasis on syntactic issues. Prerequisite: CPSC 320 or 625.

641. Computer Graphics. (2-2). Credit 3. Representation of three dimensional models; hidden edge/surface removal; shading models; transparency; intensity and color. Current topics in interactive graphics; animation, surface patches and ray tracing. Prerequisite: CPSC 441.

643. Robotics Programming. (2-2). Credit 3. Computational issues of robot arm kinematics, dynamics and control; trajectory planning and execution; contact sensors: functions, calibration and use; computer vision for robot manipulation; integration of sensor and motor systems; applications of robotics. Prerequisite: CPSC 320.

651. Simulation I. (3-0). Credit 3. Introduction to simulation and comparison with other problem-solving techniques; simulation methodology including generation of random numbers and variates, time flow mechanisms, sampling considerations, and validation and analysis of simulation models and results; survey of discrete simulation languages; applications of simulation, including operating systems and networks. Prerequisites: Graduate classification and knowledge of a minimum of three programming languages; CPSC 202.

652. Simulation II. (3-0). Credit 3. Advanced simulation and modeling. Overview of queuing theory, stochastic processes and mathematical and statistical modeling. Continuous and hybrid simulation. Research areas in simulation including language issues, distributed simulation, artificial intelligence, graphics and support environments. Real-time simulation, simulation in manufacturing and simulation of computer networks. Prerequisite: CPSC 651 or INEN 625.

653. Computer Methods in Applied Sciences. (3-0). Credit 3. Use of modern and classical algorithms in obtaining numerical solutions to problems from the physical sciences. Student development of a repertoire of computation techniques. Linear and nonlinear least squares, spectral analysis, solution of initial and boundary value problems in ordinary and partial differential equations. Prerequisite: CPSC 442 or MATH 417.

659. Parallel/Distributed Numerical Algorithms and Applications. (3-0). Credit 3. A unified treatment of parallel and distributed numerical algorithms; parallel and distributed computation models, parallel computation of arithmetic expressions; fast algorithms for numerical linear algebra, partial differential equations and nonlinear optimization. Prerequisite: MATH 304 or equivalent. Cross-listed with ELEN 659.

661. Integrated Systems Design Automation. (2-2). Credit 3. VLSI design systems and their levels of abstraction; theoretical limitation to computation using VLSI; algorithms for general VLSI design: for layout, for processor/multiprocessor network organization, and for organizations with high wire area; systolic array processing; covering and memory repair; matching and reconfiguration; laboratory practice in the use and evaluation of algorithms for integrated systems design. Prerequisite: CPSC 464.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program nor twice in Ph.D. program.

685. Problems. Credit 1 to 4. Research problems of limited scope designed primarily to develop research technique.

689. Special Topics in . . . Credit 1 to 4. In-depth study in areas relating to specific student interest, recent advances and societal problems in computer science. Topics will normally vary and this course may be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation.

DEPARTMENT OF CONSTRUCTION SCIENCE

D. L. Bilbo, W. A. Brown, G. B. Browning (Interim Head), W. L. Buckingham, M. L. Coody, J. W. Craig, Jr.*, J. de Jong, J. A. Epling, C. W. Graham, L. W. Grosse, R. J. Kruhl, R. P. Maher, J. H. Marsh III, C. D. McMullan, A. Pedulla, R. O. Segner, N. Stubbs, W. D. Tiner, F. J. Trost

*Graduate Advisor

The master of science in construction management program is an advanced multi-disciplinary course of study in construction techniques, business management and law. Graduates are prepared for careers in the management of commercial, industrial, institutional, civil and military construction, in the roles of contractor, developer, subcontractor, owner's representative or consultant.

Program course work emphasizes construction planning, estimating, scheduling, cost control, financial management, techniques, quality control, contracts and other legal matters, and personnel and labor relations.

The 36 hour program consists of 18 hours of required core courses and 18 hours of elective courses form both the construction science curriculum and the related disciplines. This program provides flexibility in allowing the student to focus on individual career goals.

Selected prerequisite courses will be required of individual students as necessary to provide the foundation needed to accomplish the studies required in the master's program.

(COSC)

617. Building Construction Practices I. (3-0). Credit 3. Innovative building construction methods.

618. Building Construction Practices II. (3-0). Credit 3. Construction problems relating to building foundations and concrete structural frames. Prerequisite: COSC 428 or equivalent.

619. Building Construction Practices III. (3-0). Credit 3. Cost estimating process (conceptual and definitive); cost analysis methods; bidding and construction contract procedures; case studies of subcontractor bidding practices; computer applications in estimating and cost analysis; compiling bidding data based on past labor productivity rates.

620. Building Construction Practices IV. (3-0). Credit 3. Theory and case studies relative to management of construction business operations with special reference to current business practices employed by construction firms.

621. Construction Scheduling. (3-0). Credit 3. Types of construction schedules; case studies of critical path schedules and allocation of resource needs for multi-story and multi-building commercial projects. Prerequisite: COSC 619 or approval of instructor.

622. Construction Resources. (3-0) Credit 3. Identification and analysis of the factors affecting resources of the construction industry on a local, regional, national and international level. Prerequisite: COSC 620 or approval of instructor.

628. Applications of Construction Law. (3-0). Credit 3. Analysis of construction law and the construction process; legal problems in the bidding process and in the performance of the contract. Prerequisite: COSC 479 or approval of instructor. Cross-listed with CVEN 630.

629. Tort Liability in the Construction Industry. (3-0). Credit 3. Risk liability in the construction industry, tort law, negligence, products liability and the role of liability insurance and the professional liability of engineers and building constructors. Prerequisite: COSC 454 or approval of instructor.

630. Systems Approach to Construction Management. (3-0). Credit 3. Concepts, relationships and techniques of decision analysis; application of methodology and techniques to major decisions faced by construction managers. Prerequisite: Graduate classification.

631. Supervision of the Construction Workforce. (3-0). Credit 3. Individual and group workforce behavior as it affects construction productivity; unique motivational and demotivational behavior characteristics; models of supervisory practice; effect of goal setting, management participation, work incentives and other reinforcers on construction workers.

633. International Construction Contracting. (3-0). Credit 3. Special problems, opportunities and procedures related to international construction projects; impact of social, cultural, legal and financial aspects of international contracting; logistics of labor, materials and equipment in a foreign environment; recent construction activity, past trends and future developments for selected countries.

681. Seminar. (1-0). Credit 1 each semester. Discussion and review of current practice in building construction.

685. Problems. Credit 1 to 6. Individual problems in the area of building construction involving the application of theory and practice. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified field of construction management. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis.

COUNSELING PSYCHOLOGY

(See Educational Psychology)

DAIRY SCIENCE

(See Animal Science)

DEPARTMENT OF ECONOMICS

J. W. Allen, R. K. Anderson, L. Auernheimer, B. H. Baltagi, R. C. Battalio, M. R. Baye, E. K. Browning, J. L. Burke, D. R. Deere, M. E. Deily, R. Del Villar, R. F. Gilbert, M. L. Greenhut, J. M. Griffin, T. J. Gronberg, J. R. Hanson II, H.-S. Hwang, D. W. Jansen, G. Lozada, S. C. Maurice, N. L. McKay, J. R. Moroney, W. S. Neilson, S. Pejovich, W. R. Reed, M. O. Reynolds*, T. R. Saving (Head), G. Tian, J. B. Van Huyck, S. N. Wiggins

*Graduate Advisor

Graduate study in economics leads to the degrees of master of science and doctor of philosophy. The graduate program develops theoretical and quantitative skills and analyzes a broad range of contemporary policy issues in order to prepare students for careers in teaching, research, business and government.

To enter the graduate program in economics, the student should present undergraduate credits in economics, although an undergraduate major in economics is not necessary. Additional preparation should include work in mathematics and statistics. The department has no foreign language requirement for a graduate degree in economics.

ECONOMICS
(ECON)

600. Economic Analysis for Public School Personnel. (3-0). Credit 3. Basic economic analysis and reasoning for public school personnel. Understanding how the American economic system is arranged and operates; the role of markets, prices and government. Not to be used towards degree in economics.

601. History of Economic Thought. (3-0). Credit 3. Survey of economic analysis from Adam Smith to modern times; includes classical, Marxist, Neoclassical, Keynesian, and monetarist economic theories; original works of Smith, Malthus, West, Ricardo and Mill. Prerequisite: Approval of instructor.

602. Economics for School Personnel. (3-0). Credit 3. Policy-related issues in macro- and microeconomics; the budget deficit; inflation, unemployment; the U.S. trade imbalance; tax reform; social security; agricultural subsidies; regulations; unions and labor markets; health care; poverty; protectionism; economic development in Third World countries; OPEC. Not to be used toward a degree in economics.

603. Public Economics I. (3-0). Credit 3. Economics of taxation and public spending; theoretical and empirical analysis of the shifting and incidence of income, commodity and property taxes; models of optimal taxation and public spending; analysis of taxation and spending in a federal system of government. Prerequisite: Approval of instructor.

604. Public Economics II. (3-0). Credit 3. Economics of collective action; theoretical and empirical analysis of externalities; externalities and public policy; the demand and supply of public goods; economic analysis of alternative systems of public choice; models of bureaucratic behavior. Prerequisite: ECON 629 or approval of instructor.

605. American Economic Growth and Development Since the Industrial Revolution. (3-0). Credit 3. World economic development since the Industrial Revolution; American experience and current economic problems of less developed countries extensively discussed; policy issues facing the Third World seen in historical as well as economic perspective.

607. Foundations of Microeconomic Theory. (3-0). Credit 3. Examination of positive and normative analysis in economic theory; emphasis on policy applications of the theory. Prerequisite: MATH 230 or equivalent; ECON 323 or equivalent; or approval of instructor.

609. Human Resource Economics I. (3-0). Credit 3. Valuation and allocation of human resources. Labor supply of households, labor supply over the life-cycle, determination of wages, human capital, migration, education, labor markets and population. Use of the testable implications of theory and of evidence to explain observed labor market behavior. Prerequisite: ECON 629 or equivalent.

610. Human Resource Economics II. (3-0). Credit 3. Selected topics in labor markets; unemployment, earnings differentials, effects of occupational licensing, trade unions, income distribution, military manpower and the draft, effects of minimum wage and equal pay provisions, effects of welfare programs, the professional athlete's labor market and others. Developing and analyzing empirical problems. Prerequisite: ECON 629 or equivalent.

611. Foundations of Macroeconomic Theory. (3-0). Credit 3. Development of modern static national income analysis from general equilibrium system. Roles of fiscal and monetary policy in promoting economic stability. Prerequisites: ECON 323, 410, MATH 230 or equivalent.

619. Theory of the Firm in Economic Space. (3-0). Credit 3. Impacts of distance on classical economic markets and the theory of the firm. Prerequisite: ECON 323 or approval of instructor.

621. Regional Science I. (3-0). Credit 3. Survey of regional economic analysis; industrial and residential location analysis; regional delineation; factor mobility and commodity movements; interregional input-output models; income accounting, balance of payments, gravity models; regional economic growth. Prerequisite: Approval of instructor.

628. Urban Economics. (3-0). Credit 3. Economic analysis of structure, functions and problems of urban areas; theory of urban, industrial and residential location; land use patterns; urban economic growth and development; and such problem areas as urban poverty, renewal, housing, traffic congestion, pollution and urban public economy. Prerequisite: Approval of instructor.

629. Microeconomic Theory I. (3-0). Credit 3. Core ideas in theoretical microeconomics; theory of consumer and firm; theory of competitive output and factor markets. Prerequisite: Approval of instructor.

630. Microeconomic Theory II. (3-0). Credit 3. Advanced treatment of consumer and production theory; general equilibrium and welfare analysis. Prerequisites: ECON 629; ECMT 660.

635. Monetary Theory. (3-0). Credit 3. Traditional and modern theories of money. General equilibrium systems and role of money in determination of prices, interest rate, income and employment. Prerequisite: ECON 636.

636. Macroeconomic Theory I. (3-0). Credit 3. Theory of consumption, investment, money, interest, inflation and employment. Prerequisite: ECON 410 or 611.

637. Monetary Policy. (3-0). Credit 3. Effect of monetary policy on aggregate economic activity and distribution of resources. Effectiveness of various policies; optimal policy in light of various institutional restrictions that exist. Prerequisite: ECON 635.

639. Economic Analysis of Regulated Enterprise. (3-0). Credit 3. Extent of governmental regulation in economy of U.S. economy; analysis of political processes determining regulation; impact of regulation on pricing, resource allocation, and income distribution. Prerequisite: ECON 425 or approval of instructor.

642. Comparative Economic Systems. (3-0). Credit 3. Impact of economic systems on welfare; per capita income, growth, and equity; analysis of alternative legal structures, rules, traditions and institutions on efficiency in production and distribution. Prerequisite: Approval of instructor.

646. Macroeconomic Theory II. (3-0). Credit 3. Dynamic models, open economies, disequilibrium analysis, unemployment and inflation. Traditional macro models and recent developments in macro theory. Prerequisite: ECON 636.

649. Industrial Organization I. (3-0). Credit 3. Industry structure, conduct, and performance described and analyzed with tools of microeconomics. Prerequisite: Approval of instructor.

650. Industrial Organization II. (3-0). Credit 3. Behavior of markets operating under conditions of imperfect information. Construction and scientific evaluation of models designed to explain industry performance. Prerequisite: ECON 649 or approval of instructor.

651. International Economic Policy. (3-0). Credit 3. Balance of payments and adjustment to national and international equilibria; determination of exchange rates under various monetary standards, capital movements, exchange controls and international monetary organization. Prerequisite: ECON 611 or equivalent.

652. International Trade Theory. (3-0). Credit 3. Classical and neoclassical models of international trade. International price formation, patterns of trade and gains from exchange;

specialization and comparative advantage; factor proportions, factor prices and the Heckscher-Ohlin theorem; foreign trade and growth; tariffs, customs unions and commercial policy. Prerequisite: ECON 630 or approval of instructor.

655. Experimental Economics. (3-0). Credit 3. Experimental methods in choice behavior experiments, survey research, planned economic environments and animal experiments. Prerequisite: Approval of instructor.

679. Theoretical Economics. (3-0). Credit 3. Topics in theoretical economics including dynamic optimization, uncertainty and game theory. Prerequisites: ECON 629 and ECMT 669.

681. Seminar. (1-0). Credit 1. Reports and discussions of current research and presentations by visiting economists. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 3 each semester. Directed individual instruction in selected problems in economics not related to thesis or dissertation. Prerequisites: Graduate major or minor in economics; approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of economics. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Economic Research. (3-0). Credit 3. Design of research experiments in various subfields of economics, and evaluation of research results with the aid of examples taken from the current scientific literature.

691. Research. Credit 1 or more each semester. Thesis research.

See AGEC 603 and 633 for description of related courses.

ECONOMETRICS
(ECMT)

660. Mathematical Economics I. (3-0). Credit 3. Use of selected types of mathematical tools in economic theory.

661. Mathematical Economics II. (3-0). Credit 3. Fundamental properties of integral calculus, difference and differential equations, and their use in economic theory. Prerequisite: ECMT 660 or equivalent.

663. Econometrics I. (3-0). Credit 3. Empirical distributions of economic variables; elementary discrete and continuous distributions expressing econometric hypotheses, distributions of estimators and test statistics.

664. Econometrics II. (3-0). Credit 3. Use of statistics in economic theory as device for testing hypotheses, formulation concepts and economic forecasting. Prerequisite: ECMT 663 or equivalent.

665. Econometric Theory and Programming. (3-0). Credit 3. Stochastic and nonstochastic model formulation, identification, methods of solution and interpretation of results; applications of theory and methods to significant economic problems. Prerequisite: ECMT 663, 664, STAT 610 (or registration therein) or approval of instructor.

666. Model Building in Econometrics. (3-0). Credit 3. Tools of mathematical and variational programming and statistics used to present received theory and to solve newly formulated problems. Prerequisite: ECMT 663.

668. Risk and Uncertainty. (3-0). Credit 3. Methods used to introduce risk and uncertainty into various economic models; analysis of behavior of individuals, firms and markets in risky situations. Prerequisite: ECMT 660.

669. Fundamental Mathematics for Economists. (3-0). Credit 3. Mathematics of nonlinear programming; applications to micro-theoretic models of demand and production. Fundamental results from matrix theory and multivariate differential calculus. Systems of differential equations and stability analysis and their economic applications.

670. Advanced Mathematical Economics. (3-0). Credit 3. Theory of competitive markets, existence and stability developed in positive and normative analysis. Optimal growth for a macro economy under alternative technologies. Prerequisite: ECMT 669.

674. Advanced Econometric Theory. (3-0). Credit 3. Empirical distributions of economic variables. Elementary discrete and continuous distributions expressing econometric hypothesis, distributions of estimators, and test statistics. Continuation of ECMT 664. Prerequisite: ECMT 664.

686. Applied Econometrics. (3-0). Credit 3. Estimation problems associated with production, cost and demand systems; use of time series, cross section and panel data sets; applications include energy demand modelling. Prerequisites: ECMT 663 and ECON 630.

DEPARTMENT OF EDUCATIONAL ADMINISTRATION

M. J. Bratlien*, D. S. Carpenter, Jr., G. B. Chisolm, B. R. Cole, D. C. Corrigan, J. M. Dillard, D. A. Erlandson (Head), H. L. Hawkins, D. Hinojosa, J. R. Hoyle, G. R. Johnson, J. F. McNamara, S. L. Stark, L. Stevenson, P. T. West, C. L. Whetten

*Graduate Advisor

The Department of Educational Administration provides several alternative areas of study. Degrees are offered on the master's and doctoral levels. Interdisciplinary study in the social and behavioral sciences and in public school administration leads to a well-rounded program for the school and college administrator. Preparation for the college professorship in educational administration and research is available. Flexibility in program planning provides adaptation to management in business, industry and related professions.

Programmatically, the diversity of training and experience is for the principal, or middle administrator, and the superintendent on the public school level; and the president, dean, director, department head and professor on the college/university level. Concentrated course work is available in community education, higher education, school law and management, public relations, public school administration, internships, planning and evaluation, research design and techniques, field services, and inner-city and multi-cultural studies.

All students admitted to the doctoral degree programs in educational administration are expected to demonstrate competency in nine areas of study related to educational administrative settings. The following areas comprise the educational administration common core: economic, legal, organizational, sociological, political and educational foundations; communication; teaching/learning environments; and planning, research and evaluation.

Professional Certification — Professional certification programs are offered for superintendents, principals and middle administrators including assistants, directors, deputies, school business managers and other central office personnel. Texas Education Agency-approved plans are adapted to the aspirations and needs of individuals. Basic requirements include a teaching certificate, master's degree and two years of creditable classroom teaching experience. Two levels of certification are available — middle management and superintendency.

Administration of Higher Education — Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling, or administering in junior and community colleges, technical colleges, or universities. Within the framework of a number of doctoral programs at Texas A&M University, it is possible to pursue a concentration in higher education as a cognate area. Courses available include: EDAD 610, 625, 626, 655; EDCI 606, 649; EPSY 669, 670; INED 604; ADEX 645 and SAED 624.

Community Education — The specialization focuses on the philosophy and implementation of community education as a vehicle for total community involvement in the educational process while stressing the interdisciplinary nature of leadership in the community. It is aimed at preparing public school administrators or administrators in other public sectors. In cooperation with the Mott Foundation, the Texas A&M Center for Community Education provides direct services to school districts and communities throughout the state.

Instructional Management — Graduate study in educational administration emphasizing instructional management is designed to prepare curriculum directors, assistant/associate/deputy superintendents of curriculum and instruction, broadly based curriculum instructional supervisors and university professors of education. Such studies may be pursued in either the Department of Educational Administration or the Department of Educational Curriculum and Instruction and under either the

Ed.D. or Ph.D. program. Texas candidates may also qualify for the mid-management administrator's certificate and the supervisor's certificate. Out-of-state candidates should check with their state education agencies as to whether this program would satisfy their certification requirements.

Public Relations — This multidisciplinary graduate studies specialization in educational administration places special emphasis on communications. Supporting fields also include architecture, computing science, business, curriculum and instruction, English, industrial education, industrial engineering, psychology, philosophy, sociology and urban and regional planning. This specialization is designed to prepare students for positions as public relations specialists in education, business, government and industry.

Research, Planning and Evaluation — The department participates in interdisciplinary planning, research and evaluation offered in cooperation with other departments in the College of Education. Prospective doctoral students who wish to develop an interdisciplinary supporting field in educational planning, research and evaluation should examine the interdisciplinary studies option which is presented in the description of graduate courses in interdisciplinary education.

The Principalship — Graduate study in educational administration emphasizes professional competency along behavioral dimensions identified with the positions of elementary and secondary school principals. Heavy reliance for professional development is placed upon field experiences and field related simulation materials.

Training and Development — Master's degree students seeking preparation for training and development positions in the corporate sector or in governmental agencies may elect to include that specialization within their degree programs. The specialization includes courses in the development, operation, management and evaluation of training and development programs, strategic planning, communications, marketing and organizational behavior, and a training and development internship appropriate to the major field of study.

(EDAD)

604. The Elementary School Principalship. (3-0). Credit 3. Role of the elementary school principal in organization and administration of elementary schools; management of instruction, educational program planning, legal problems, evaluation and reading programs. Prerequisite: Approval of instructor.

605. The Secondary School Principalship. (3-0). Credit 3. Role of the principal in the organization of junior and senior high schools; preparation for instructional management, program planning, evaluation and scheduling. Prerequisite: Approval of instructor.

608. School Finance and Business Management. (3-0). Credit 3. School funds on local, state and federal level; budgeting, data processing; other systems of accounting and reporting. Supply management as related to school efficiency. Maintenance of buildings, grounds and equipment. Prerequisites: EDAD 604, 605, 615 or approval of department head.

609. Public School Laws. (3-0). Credit 3. Constitutional provisions, statutory laws, court decisions and regulations governing public schools with special reference to Texas and federal relationships.

610. Higher Education Law. (3-0). Credit 3. Legal aspects of administration in institutions of higher education. Statutes and case law related to liability, due process, student rights, admission, employee relations and property use. Prerequisites: Graduate classification; approval of instructor.

611. Higher Education Business and Finance. (3-0). Credit 3. Business management and financial aspects of administration in higher education; federal and state funding, institutional planning, budgeting and controlling, sources of financial support and business operations in higher education. Prerequisites: Graduate classification and approval of instructor.

612. Policy Issues in the Administration of Higher Education. (3-0). Credit 3. Examination of conflicting positions on policy issues of importance in higher education and their direct implications for participants. Prerequisites: Graduate classification and approval of instructor.

613. Educational Facilities Planning. (1-6). Credit 3. Present and future building and equipment needs of school units; efficiency of present plant, operation and maintenance, planning building program; field work as part of a group school plant study.

615. School Superintendency. (3-0). Credit 3. Examination of the role of the superintendent of schools as the chief educational officer of the local school district. Major emphasis is on the functions and relationships of the superintendent. Prerequisite: EDAD 604, 605 or approval of instructor.

616. Administration of Staff Personnel. (3-0). Credit 3. Personnel organization and administration in school systems. Relationship of individual to organization. Organizational health, staffing, remuneration, appraisal, ethics, security, inservice and negotiations. Prerequisite: EDAD 639 or approval of instructor.

618. Educational Administration in Cross Cultural Environments. (3-0). Credit 3. Designed to provide educational administrators insights and background into the life styles, values and aspirations of minority Americans as related to the administrative process.

619. Contemporary Dimensions of Administering Urban Schools. (3-0). Credit 3. Causes and consequences of racial and socio-economic isolation, impact of school desegregation, urban school politics, alternatives for urban schools, decentralization, community control, urban population trends and housing patterns.

620. Educational Program Evaluation. (3-0). Credit 3. Theory and practice of evaluation of instructional programs including research methods and design strategies to measure program outcomes. Skills to evaluate personnel and projects included as components of evaluation models and management of educational evaluation functions. Open to all graduate students in education.

621. Educational Planning/Futurism. (3-0). Credit 3. Concepts and skills to prepare educational leaders to anticipate and manage the future. System theory, futures methodology, planning models and scenario writing. Designing educational programs for the 21st century. Prerequisite: Approval of instructor.

626. Issues and Trends in Community College Administration. (3-0). Credit 3. Community college in relation to other institutions of higher education. Assessment of community college enrollment trends, curriculum changes, personnel problems, finance patterns (federal and state) and contemporary issues. Prerequisite: EDAD 625.

634. Leadership Function in Literature. (3-0). Credit 3. The leadership function applied to educational administration settings through a study of organizational concepts and values within a literary context, using the novel, drama and poetry. Prerequisite: EDAD 639 or approval of instructor.

635. Administration of Special Services. (3-0). Credit 3. To help administrators, counselors, supervisors and teachers develop an understanding of functions, operation and evaluation of special services which support the educational program. Individual study of content and on-site evaluations of organization and administration of school services programs.

636. Practices and Problems in Educational Public Relations. (3-0). Credit 3. Selected contemporary problems and practices in educational public relations; case study approach as a decision-making strategy. Prerequisite: EDAD 640 or approval of instructor.

637. Administration of Change in Educational Organizations. (3-0). Credit 3. Relationships among individual and group behaviors; roles of administrators. On-site analysis of educational organizations and change principles. Prerequisite: Approval of instructor.

638. Current Issues in Community Education. (3-0). Credit 3. Current educational issues affecting public education; merging and alternative models of community education. Prerequisites: EDAD 641; approval of instructor.

639. Foundations of Educational Administration. (3-0). Credit 3. Selected historical, philosophical and sociological foundations and developmental dimensions of educational administration.

640. School-Community Relationships. (3-0). Credit 3. Interpretation of schools to community publics. Promotion of school-community relations through media. Roles of administrators, teachers, non-teaching personnel, pupils, parents and lay groups.

641. Community Education. (3-0). Credit 3. Structure, purpose and strategies of community education as they relate to public school administration.

651. Orientation in Business Principles and Procedures. (2-2). Credit 3. Interdisciplinary survey using management science and operations research procedures from various fields of business as a means to improve decision-making and policy-planning educational organizations. Emphasis on microcomputer applications. Case studies. Field studies.

652. Educational-Governmental Relationships. (3-0). Credit 3. Interdisciplinary survey course using various fields in political science, comparative government, and American and state history. Interrelationships of educational administration to political organizations.

653. The Nature and Problems of Administrative Behavior. (3-0). Credit 3. Interdisciplinary survey course using case study method. Designed to enhance understanding of organizational theory and the appropriate techniques in decision-making, communication and staff relations required by the educational administrator. Prerequisite: Master's degree or approval of instructor.

654. Problem Resolution in Educational Organizations. (3-0). Credit 3. Focuses on concepts and skills to prepare school administrators, counselors, college student affairs professionals, and school and counseling psychologists to anticipate and cope with conflict emerging from interpersonal interaction.

655. Administration of Higher Education. (3-0). Credit 3. Survey of management principles in higher education. Functions in delegation, direction, operation, governance and financing applied to postsecondary institutions.

656. Administration of Supervisory Personnel. (3-0). Credit 3. Administration of public and private school supervisory programs; roles of administrators in the management of instructional programs in small and large schools.

681. Seminar. (1-0). Credit 1. Problems pertinent to superintendent and principal. Recent developments and research in different areas.

684. Internship. Credit 1 to 6. Designed to give the prospective educational administrator job related experience under supervision in an educational setting appropriate to the selected roles in administration indicated below. Prerequisites are determined by each specific degree, certification or program requirements. A maximum of six hours credit may be earned in each internship. Prior approval required.

(a) Community Educator
(b) Public Relations Specialist
(c) College Administrator
(d) Middle Administrator
(e) School Superintendent

685. Problems. Credit 1 to 4 each semester. Directed individual study of elected problem in field of educational administration. Prerequisite: Prior approval required.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of educational administration. May be repeated for credit.

690. Theory of Educational Administration Research. Credit 3 to 6. Design of research and inquiry in various areas of educational administration. Application of models and research procedures from the social and the management sciences to policy issues and problems in educational organizations. Case studies. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

DEPARTMENT OF EDUCATIONAL CURRICULUM AND INSTRUCTION

P. A. Alexander, D. G. Armstrong, T. R. Blair, J. K. Campbell, J. V. Clark, B. R. Cole, D. W. David, J. J. Denton, C. J. Dockweiler*, V. E. Florez-Tighe, D. C. Godwin, R. K. James, D. L. Janke, G. R. Johnson*, R. J. Kansky, J. B. Kracht*, P. J. Larke, J. E. Morris, D. E. Norton, W. H. Peters (Head), J. H. Rollins, W. H. Rupley, M. C. Sadoski, A. C. Seaman, R. E. Shutes*, J. C. Stansell, W. F. Stenning*, D. L. Wiseman

*Graduate Advisor

Graduate courses in the Department of Educational Curriculum and Instruction are designed to advance the knowledge and develop the skills of persons in instructional, supervisory and curriculum development roles at all levels of education, from elementary school through the university. Individually planned programs lead to the

master of education, master of science, doctor of education and doctor of philosophy degrees in educational curriculum and instruction. Graduate programs leading to initial certification may be used as a partial requirement for advanced degrees. Degree programs may be written to meet the requirements for professional teaching and supervisor certificates approved by the Texas Education Agency.

Individual courses and sequences of courses deal with the theory, research and practice related to strategies of teaching, approaches to curriculum development and revision, and techniques of supervision. Though courses are specifically intended to assist practicing school personnel, they have direct relevance to students majoring in other disciplines who intend to teach their subject at either the public school or college level. Departmental seminars supplement the individual counseling of graduate students and serve to interrelate the content of program courses.

Information about prerequisites, research or language requirements can be obtained from the department office. Requirements will be determined by the student's advisory committee.

Curriculum Director — This area of specialization is aimed at developing public school and higher education staff who can design, develop, install and evaluate curriculum across a broad range of subject matter. Extensive theory and application in curriculum are provided with opportunities to participate in the department's curriculum laboratory.

Early Childhood Education — Graduate study in this area of specialization is designed for classroom teachers, supervisors and administrators to enhance teaching strategies, classroom management, parental involvement, program development and operational skills when working with young children. Developmental characteristics and needs of preschool children provide the basis from which early childhood programs, facilities and methods are derived for advanced study.

Educators for Diverse Settings — Within the framework of existing doctoral programs, individuals may pursue a specialization aimed at developing and enhancing educational skills for use in non-school settings. This program is particularly appropriate for those individuals interested in pursuing educational leadership positions in business, industry, agency, and/or governmental settings.

Elementary Education — The department offers a wide range of course work designed to benefit teachers, supervisors and administrators who work at the elementary level. Various emphases can be developed to reflect an individual's specific interests. Generic program components include curriculum development, instructional planning, trends and issues in elementary education.

Higher Education — Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling, or administering in junior and community colleges, technical colleges, or universities. Within the framework of a number of doctoral programs at Texas A&M University, it is possible to pursue a concentration in higher education as a cognate area. Courses available include: EDAD 610, 625, 626, 655; EDCI 601, 606, 649; EPSY 669, 670; INED 604; ADEX 645 and SAED 624.

Instructional Management — Graduate study in educational curriculum and instruction emphasizing instructional management is designed to prepare curriculum directors, assistant/associate/deputy superintendents of curriculum and instruction, broadly based curriculum/instructional supervisors and university professors of education. Such studies may be pursued in either the Department of Educational Administration or the Department of Educational Curriculum and Instruction and under either the Ed.D. or Ph.D. program. Texas candidates may also qualify for the mid-management administrator's certificate and the supervisor's certificate. Out-of-state candidates should check with their state education agencies as to whether this program would satisfy their certification requirements.

Language Arts Education — This area of specialization is designed for the professional development of persons involved in teaching, curriculum development, research, evaluation and administration in the area of language arts. It is intended to prepare students for language arts positions in public schools, community colleges, senior colleges and universities, and state educational agencies as well as related positions in business and industry.

Mathematics Education — Graduate preparation is offered in the several areas related to the teaching of mathematics and the mathematics curriculum. This area of specialization is aimed at preparing master teachers of mathematics, curriculum specialists in the discipline, and mathematics education specialists for college-level teaching and research. Students from areas other than education will find ample opportunities to develop an appropriate level of expertise in mathematics education.

Reading — This area of specialization focuses on the theoretical and research based aspects of the reading process, reading acquisition and reading diagnosis-remediation. Emphasis is also placed on the implications emerging from theory and research as they relate to both the preparation and improvement of preservice and inservice reading teachers' instruction.

Research, Planning and Evaluation — The department participates in interdisciplinary planning, research and evaluation offered in cooperation with other departments in the College of Education. Prospective doctoral students who wish to develop an interdisciplinary supporting field in educational planning, research and evaluation should examine the interdisciplinary studies option which is presented in the description of graduate courses in interdisciplinary education.

Science Education — This area of specialization focuses upon preparing individuals to become better science teachers at all levels of education. It includes courses from a selected science area plus science education courses.

Secondary Education — The department offers a wide range of course work designed to benefit teachers, supervisors and administrators who work at the secondary education level. Various emphases can be developed to reflect an individual's specific interests. Generic program components include curriculum development, instructional planning, trends and issues in secondary education.

Social Studies Education — Individuals selecting this area of specialization are provided with a combination of experiences selected from courses focusing on professional social studies education, general educational curriculum and instruction, and history and the social sciences. Participants are introduced to ideas of leading social studies educators particularly as those ideas relate to preparation of curricula and to development of instructional practices.

Supervisor — The department provides the program necessary for certification as an elementary or secondary school supervisor.

Training and Development — Master's degree students seeking preparation for training and development positions in the corporate sector or in governmental agencies may elect to include that specialization within their degree programs. The specialization includes courses in the development, operation, management and evaluation of training and development programs, strategic planning, communications, marketing and organizational behavior, and a training and development internship appropriate to the major field of study.

EDUCATIONAL CURRICULUM AND INSTRUCTION (EDCI)

600. Higher Education: The College Curriculum. (3-0). Credit 3. Compare curricula of early colonies and present day institutions; examine classical curriculum, the elective curriculum, the comprehensive university, the research university; analyze recommendations made by national committees, curriculum writers and higher education personnel. Prerequisites: Admission to graduate programs and completion of at least 12 semester hours of graduate work in a major field of study.

601. College Teaching. (3-0). Credit 3. Review of research studies related to college settings; college-level teaching strategies; cognitive interaction analysis.

602. Cultural Foundations of Education. (3-0). Credit 3. Contributions of behavioral sciences applied as analytic tools in solving problems of curriculum and instruction.

605. Creative Application of Technology to Education. (2-3). Credit 3. Identification and solution of learning problems using a learning systems approach; creative application of educational technology (programmed instruction, electronic carrels, etc.).

607. Programs and Procedures in Supervision. (3-0). Credit 3. Designed for teachers, supervisors and administrators. Philosophy, organization and administration of supervision of both elementary and secondary schools. Required for mid-management and supervisor's certificate.

608. Supervision of Student Teachers. (3-0). Credit 3. Performance objectives, observation systems, conferencing and evaluation procedures related to supervision of student teaching. Public school teacher's role in supervision of student teachers.

609. Reading and Interpreting Educational Research. (3-0). Credit 3. Components of a research report; interpreting and evaluating sampling procedures and instrumentation; interpreting selected descriptive and inferential statistics; interpreting and critiquing reports of historical descriptive, correlational and experimental studies in education. Prerequisite: Graduate classification. Co-requisite: EPSY 439 or STAT 303 or STAT 651.

610. Second Language Assessment and Development. (3-0). Credit 3. Second language assessment and development stressing classroom situations to teach second language acquisition. Prerequisite: Graduate classification.

611. Teaching English as a Second Language. (3-0). Credit 3. Translation of theory into practice stressing various methods and techniques in ESL; relationship of language development, culture and conceptual processes to language teaching. Prerequisite: Graduate classification.

612. Bilingual/ESL Content-Area Instruction. (3-0). Credit 3. Integrating English language instruction with content-based ESL instruction in science, mathematics and social sciences for non-English speaking students. Prerequisite: Graduate classfication.

613. Spanish/English Reading for Bilinguals. (3-0). Credit 3. Developmental processes in second language reading; nature of skill transfer and the application of transfer principles in the classroom. Prerequisite: Graduate classification.

614. ESL for International and Intercultural Settings. (3-0). Credit 3. International and intercultural teaching practices with major emphasis on second language instruction in an international setting. Prerequisite: Graduate classification.

615. Classroom Practice in Adult ESL. (3-0). Credit 3. Literacy practice issues in adult ESL literacy leading to assessment, instructional planning, curriculum development and program evaluation. Prerequisite: Graduate classification.

616. Teaching in Spanish in the Bilingual Classroom. (3-0). Credit 3. Acquisition of English by Spanish speakers in an elementary bilingual classroom and its relationship to instructional and curriculum issues. Prerequisite: Graduate classification.

617. Early Childhood Mathematics. (3-0). Credit 3. Development of mathematical concepts in young children from developmental and mathematical perspectives. Prerequisite: Graduate classification.

618. Teaching Elementary School Mathematics. (3-0). Credit 3. Contemporary issues in teaching elementary school mathematics; the active learning instructional mode.

619. Teaching Basic Concepts of Mathematics. (3-0). Credit 3. Content and pedagogy of middle/junior high school mathematics programs.

620. Teaching Secondary School Algebra. (3-0). Credit 3. Content and pedagogy of selected contemporary programs in school algebra.

621. Teaching Secondary School Geometry. (3-0). Credit 3. Contemporary issues in informal and formal school geometry; emerging curricular alternatives.

622. Theories of Learning and Teaching Mathematics. (3-0). Credit 3. Theoretical bases of the learning and teaching of mathematics, including an examination of the research which supports the theoretical bases.

623. Advanced Topics in the Secondary School Mathematics Curriculum. (3-0). Credit 3. Analysis of national and state standards regarding content, organization and evaluation of elective mathematics courses offered to secondary school students; focus on mathematical content to be learned, expected actions of learners and context of instuction. Prerequisites: Graduate classification; EDCI 329; approval of instructor.

624. Diagnosis and Prescription in Elementary School Mathematics. (3-0). Credit 3. Diagnostic procedures in elementary school mathematics and their potential in identifying problem areas related to elementary school children's acquisition of computational skills. Prerequisite: Graduate classification.

625. Remediating Error Patterns in Elementary School Mathematics. (2-2). Credit 3. Application of remedial techniques after identifying an elementary student's mathematical difficulties. Prerequisite: EDCI 624.

626. Geometry and Measurement in the Elementary School. (3-0). Credit 3. An investigative, exploratory approach to the development of geometric and measurement concepts in elementary school mathematics. Prerequisite: Graduate classification.

627. Historical Aspects of the Secondary School Mathematics Curriculum. (3-0). Credit 3. Historical development of basic mathematical topics comprising the current secondary school curriculum (numeration, computation algorithms, measurement systems, algebra, geometry); historical evolution of the curriculum in terms of the selection and arrangement of those topics. Prerequisites: Graduate classification; 24 hours of mathematics.

629. Educational Programming for the Gifted and Talented. (3-0). Credit 3. Theoretical issues confronting educators involved in program development for gifted and talented children and adolescents; analysis of educational perspectives and instructional implications. Prerequisite: Graduate classification.

637. Instructional Strategies: Principles and Applications. (3-0). Credit 3. Analysis of teaching-learning environments for the purpose of improving instruction. Instructional strategies. Prerequisites: EDCI 644 and 673 or approval of instructor.

638. Trends in Curriculum and Instruction. (3-0). Credit 3. Recent research and development in theories and practices of curriculum and instruction. Curriculum innovations, school organization and new instructional media.

643. Current Issues in Elementary Education. (3-0). Credit 3. Current issues affecting the elementary school. Curriculum, instruction and organization in light of current social and educational change. Prerequisite: Elementary Provisional Certificate or equivalent.

644. Curriculum Development. (3-0). Credit 3. Curriculum development. Bases of curriculum design. Problems of balance, scope, organization, sequence, selection and articulation.

645. Society and Education in World Perspective. (3-0). Credit 3. Comparative education; interrelationships among societal institutions and particular roles that education plays in different cultures and political systems. Prerequisites: EDCI 402.

646. Instruction Theory. (3-0). Credit 3. Theoretical basis for research and training in instruction. Systematic study of existing research on key factors influencing instructional effectiveness. Exploration of interaction among variables of instruction. Prerequisite: EDCI 675.

647. Curriculum Theory. (3-0). Credit 3. Theoretical basis for curriculum conceptualization, development, evaluation and implementation. Value and empirical basis of curriculum decision-making strategies for curriculum change. Prerequisite: EDCI 644.

648. Curriculum Management. (3-0). Credit 3. Determination of appropriate levels of curriculum structure; planning and leading curriculum development, implementation and evaluation; estimating time and cost requirements and organizing personnel for curriculum projects and programs; defining curriculum leadership roles, responsibilities and relationships. Prerequisites: EDCI 644 and 647 or approval of instructor.

651. Advanced Strategies for Teaching Young Children. (3-0). Credit 3. The young child and proven methods which enhance growth and effectively educate; examination of environmental, self directive, intervention, and peer teaching strategies and their implementation in the classroom. Prerequisite: Graduate classification.

652. Parental Involvement in Early Childhood Education. (3-0). Credit 3. Dynamics of the family unit, school-home communication systems, legalities of parent participation in the school, parent involvement, parent training and home bound programs. Development of programs with parents.

653. Classroom Management in Early Childhood Education. (3-0). Credit 3. Methods of classroom management, principles of child guidance, establishing positive educational environments, interpreting children's needs and methods of discipline as related to teaching strategies in early childhood education. Prerequisite: Approval of instructor.

654. Organization and Operation of Early Childhood Education Programs. (3-0). Credit 3. Comprehensive survey of the various types of preschool centers serving the needs of young children; operating procedures, programs and services provided. Experimental educational research projects now being conducted with young children.

655. Program Development for Early Childhood Education. (3-0). Credit 3. Developing language-experience based curriculum guides specifically for young children. Instructional theory directed toward the development of language-experience based curriculum units. Prerequisite: EDCI 644.

662. Philosophical Theories of Education. (3-0). Credit 3. Selected historical theories of education from Plato to Skinner. Evaluating educational ends and means; the nature of knowledge, its acquisition and transmission.

663. Advanced Methods of Elementary Science Education. (3-0). Credit 3. Strategies for teaching elementary school science; design and evaluation of elementary school science instruction; recent developments in elementary school science teaching.

664. Advanced Methods of Secondary Science Education. (3-0). Credit 3. Strategies for teaching secondary school science; design and evaluation of secondary school science instruction; recent developments in secondary school science teaching.

665. Science Curriculum. (3-0). Credit 3. Critical exploration of the trends and issues in school science programs; consideration of the foundations and strategies for the design, selection and evaluation of science curriculum.

666. Laboratory Methods and Management in Science Teaching. (3-0). Credit 3. Foundations, procedures and techniques associated with effective laboratory science teaching; planning, conducting and evaluating laboratory activities, facilities management and safety.

667. Research and Foundations of Science Education. (3-0). Credit 3. Analysis of research in science education with implications for improved instructional procedures; historical and philosophical bases of science teaching; learning research in elementary and secondary science teacher education.

670. Social Studies in Elementary and Secondary Education. (3-0). Credit 3. Methodology course focusing upon the implementation, both practical and theoretical, of the objectives of social studies: current trends, resource materials, demonstrations of teaching methods.

672. Curriculum and Methodology of Language Arts. (3-0). Credit 3. Advanced methodology course for teachers of language arts courses and their supervisors. Total curriculum development, attitudes and procedures for fostering developmental skills and creativity.

673. Analysis of Teaching Behavior. (3-0). Credit 3. Identification of beliefs and assumptions regarding teaching; review of research on teacher effectiveness; alternative methods for gathering data regarding dimensions of teaching behavior; development of teacher analysis systems.

675. Teaching Strategies: Patterns of Learning. (3-0). Credit 3. Learning and teaching theory and research applied to development of teaching strategies appropriate for various contents, objectives and instructional situations. Variables influencing learner behavior and approaches to optimization of teacher behavior. Prerequisite: EPSY 602 or 673 recommended.

676. Teaching Strategies: Critical Problems. (3-0). Credit 3. Critical issues in curriculum and instruction. Solving educational problems through observation and evaluation. Developing plans to gather information to improve education systems. Prerequisite: Approval of instructor.

677. Strategies for Teaching in a Culturally Pluralistic Society. (3-0). Credit 3. Research concerning the cognitive psychomotor and affective aspects of learning and teaching among culturally diverse learners; practical applications to curriculum and instruction.

678. Curriculum Development and Instructional Strategies in Teaching Composition. (3-0). Credit 3. Methods of teaching writing in the primary, elementary, and secondary grades; focuses on teaching and learning all aspects of the writing process, and development of writing across the school curriculum. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Professional roles and responsibilities, research, special topics and other issues relevant to master's and doctoral students in curriculum and instruction.

682. Seminar in. . . (1-0). Credit 1. Knowledge, skills and attitudes in educational curriculum and instruction. Specific topics will be assigned for each seminar as it is offered. May be repeated for credit.

684. Professional Internship. Credit 1 to 6 each semester. On-the-job training for educational curriculum and instruction majors under the supervision of successful, experienced personnel from the University. Conducted in a setting appropriate to the student's projected career aspirations and areas of specialization.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the field of education.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of curriculum and instruction. May be repeated for credit.

690. Theory of Curriculum and Instruction Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of curriculum and instruction. Communication of research proposals and results. Evaluation of current research of faculty and student and review of current literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

READING
(RDNG)

604. Reading Diagnosis. (2-3). Credit 3. Appraisal and diagnosis of reading problems. Practicum in administration and interpretation of individual reading inventories. Prerequisite: EDCI 649, 674 recommended.

612. Children's Literature and Literacy. (3-0). Credit 3. Critical selection and evaluation of various children's literature genres; comparative studies of children's literature; development, implementation and evaluation of research in children's literature and literacy; integration of reading and response theory into the study of literature. Prerequisite: Graduate classificaion.

613. Multicultural Children's Literature and Literacy. (3-0). Credit 3. Analysis and evaluation of Native American, Black and Hispanic children's literature; development, implementation and evaluation of research in multicultural literature and literacy; analysis of issues influencing multicultural literature and literacy. Prerequisites: Graduate classification; RDNG 612.

614. Reading Research and Trends. (3-0). Credit 3. Exploration of recent research in reading. Identification of trends and patterns in issues attached, research designs employed, and consistent findings. Generation of new research hypotheses and guidelines for improving current practice. Prerequisites: Doctoral classification; 12 graduate hours in reading.

615. Advanced Reading Diagnosis and Remediation. (3-0). Credit 3. Evolving theory, research and controversy in reading diagnosis and remediation. Analysis of trends. Prerequisites: Doctoral classification; 12 graduate hours in reading, including RDNG 604 and 642.

616. Organization and Supervision of Reading Programs. (3-0). Credit 3. Organization of school reading programs; role of reading supervisor in program implementation, staff development, program evaluation. Coordination of reading services with total curriculum. Prerequisites: Doctoral classification; approval of instructor.

642. Clinic Teaching in Reading. (1-6). Credit 3. Practicum in recognition, diagnosis, remediation and corrective procedures of reading-study problems; demonstration and laboratory analysis of physiological and psychological factors related to reading disabilities. Prerequisites: EDCI 351, RDNG 604.

649. Reading Instruction in High School and College. (3-0). Credit 3. Basic principles of reading instruction; nature and scope of total reading program; methods, materials and organization of developmental, corrective and speed-reading programs in high school and college.

650. Foundations of Reading Instruction. (3-0). Credit 3. Psychological, linguistic and physical factors related to reading performance; implications for content and teaching methods; appraisal of current research and related reading for teachers, supervisors and reading specialists. Prerequisites: RDNG 649 and 674, or approval of instructor.

674. Developmental Reading in the Elementary School. (3-0). Credit 3. Methods and materials of reading instruction in the elementary grades. Past, present and emerging programs; organization and administration of programs and classroom management; teaching reading to special groups; issues in reading.

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

C. R. Anderson, M. J. Ash (Head), D. G. Barker, W. G. Birch, G. M. Boodoo, C. A. Borman, D. Davenport, J. M. Dillard, M. Duffy, G. Garcia, Jr., E. T. Goetz, P. A. Haensly, R. J. Hall, L. H. Hope, J. N. Hughes, L. J. Juarez, J. T. Kapes, J. J. Koldus III, H. J. Kueker, J. F. McNamara, W. R. Nash, D. J. Palmer*, L. H. Parrish, R. R. Reilley, C. R. Reynolds, A. J. Roach, D. Smith, W. F. Stenning, V. L. Willson, F. F. Worchel

*Graduate Advisor

The Department of Educational Psychology offers study for the Ph.D. degree in educational psychology, counseling psychology, school psychology and vocational education. The Ed.D. is offered only in vocational education. Students seeking the Ph.D. in educational psychology may emphasize one of four areas of study: gifted and talented, human learning and development, research and evaluation (college-wide) and special education. While each of the areas can prepare students for employment as university teachers and researchers, non-academic careers can also be pursued in areas appropriate to the study programs. For example, the counseling psychology program is designed to prepare students as counseling psychologists in college and university counseling centers or other social service settings. The school psychology program prepares school psychologists to practice in schools and other health care settings. The vocational education program prepares individuals for leadership positions in the broad field of vocational education at the secondary, post-secondary and university levels as well as in other agencies that deliver education-for-work programs. Each of the areas could lead to positions with school districts as program coordinators, staff specialists and the like.

Students seeking M.Ed. and M.S. degrees may pursue a general program of study or emphasize one of the following areas: agency counseling, gifted and talented education, school counseling, college student personnel services or vocational education (M.Ed. only). School counseling prepares students for certification by the Texas Education Agency as school counselors. The department offers a 6-year Generic Special Education Teacher Training Program that leads to a master's degree in educational psychology. The training, which occurs in two phases, consists of 4 years of undergraduate training leading to a bachelor of science in educational curriculum and instruction. This phase is followed by two years of graduate study, the last of which is a full-time one year paid internship. See the *Undergraduate Catalog* for details. The vocational education program also offers Texas Education Agency certification course work in Career Investigation, Vocational Counseling and Vocational Supervision.

In conjunction with its training in all areas of study, the department operates the Counseling and Assessment Clinic as a vehicle for student preparation and as a service to the University, as well as to the public and its schools. The clinic provides a modern laboratory for practicum experiences in counseling, educational and psychological assessment and research.

Preparation as a professional in the areas of emphasis offered in the department requires attention to personal characteristics of the individual and his or her socialization into the profession as well as to successful completion of academic course work. In particular, students should exhibit an orientation toward fostering human development and possess characteristics conducive to helping relationships. Accordingly, the department requires that students desiring to pursue certification or degree programs satisfy the demands of the screening committee for the area of emphasis desired. These faculty committees require students to submit personal references, complete selected tests, and be interviewed by appropriate faculty members. Formal admission to a degree program, an area of emphasis or a certification program is contingent upon the appropriate screening committee's decision concerning the individual's total fitness and promise as a professional person in the area of emphasis for which application is made. Students in all areas of study will periodically have their total progress in professional development reviewed by a committee of the faculty offering that area of study to determine whether or not they shall be permitted to continue. All Ph.D. students in the counseling and school psychology programs are expected to undertake a series of supervised professional training experiences in addition to formal course work.

The deadline for fall admissions to all programs is **February 1.** Admissions are announced on April 1. Prospective students should contact the department's student services secretary and request a copy of the pertinent program brochure and departmental application forms in addition to contacting the Office of Admissions and Records to obtain the appropriate application forms for admission to graduate studies.

Field experiences in appropriate schools, colleges or social agencies are required in all degree programs. A full year of full-time, professional internship is required of all doctoral students in the counseling psychology program. A full-time academic year internship is required of all doctoral students in the school psychology program.

Because of the professional training involved, enrollment in a number of courses is limited to students majoring in the department. Some courses are limited to students admitted to specific areas of study. Approval by the department head is required for enrollment in these courses.

The department participates in interdisciplinary planning, research and evaluation offered in cooperation with other departments in the College of Education. Prospective doctoral students who wish to develop an interdisciplinary supporting field in educational planning, research and evaluation should examine the interdisciplinary studies option which is presented in the description of graduate courses in interdisciplinary education.

Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling, or administering in junior and community colleges, technical colleges, or universities. Within the framework of existing doctoral programs among different departments at Texas A&M University and/or within the College of Education, it is possible to pursue a concentration in higher education as a cognate area. Courses available include: EDAD 610, 625, 626, 655; EDCI 601, 606, 649; EPSY 669, 670; INED 604; ADEX 645 and SAED 624 — see the separate departments within the College of Education.

EDUCATIONAL PSYCHOLOGY
(EPSY)

602. Educational Psychology. (3-0). Credit 3. Cognitive analysis of academic skills and tests. Current cognitive views of learning, memory, problem solving, and development of skill and expertise. Effects of aptitude, motivating and task environment on academic performance. Implications for assessment and instruction.

619. Gifted and Talented Children. (3-0). Credit 3. Psychological characteristics of gifted and talented children. Introduction to identification techniques, educational programs, instructional approaches and special problems. Prerequisite: Approval of instructor.

620. Nonbiased Assessment of Special Populations. (3-0). Credit 3. Principles and techniques for nonbiased assessment of minority and culturally different children; procedures to ensure nondiscriminatory appraisal of preschool, severely handicapped, bilingual and emotionally disturbed children and youth. Implications for educational strategies. Prerequisites: SPSY 614 and approval of instructor.

622. Measurement and Evaluation in Education. (3-0). Credit 3. Principles of psychological testing applied to education. Uses and critical evaluation of achievement and aptitude, interest, and personality tests and performance in educational settings.

624. Creative Thinking. (3-0). Credit 3. Major theories and research findings regarding the creative thinking process; psychometric assessment of creative thinking abilities and methods for increasing creative behavior.

625. Test Construction. (3-0). Credit 3. Planning, construction, analysis and evaluation of written and performance tests. Test item analysis, reliability studies and validity studies. Development of test norms, score transformations and equivalent forms of tests. Prerequisites: EPSY 439 and 622 or equivalents.

626. Research Applications of Educational Measurement. (3-0). Credit 3. Psychometric theory applied to advanced problems of measurement in educational research. Principles underlying development and use of measurement methods in education. Prerequisites: EPSY 622, 625, STAT 651, 652 or equivalents.

627. Structured Personality Assessment in Counseling. (3-0). Credit 3. Personality evaluation using structured assessment instruments; variety of self-report personality inventories; the Minnesota Multiphasic Personality Inventory. Prerequisites: EPSY 622; approval of department head.

628. The Rorschach Technique with Children and Adolescents. (3-0). Credit 3. Analysis of the Rorschach Technique. Basic issues in projective assessment, scoring, interpreting, and analyzing the Rorschach, with an emphasis on its clinical use with children and adolescents. Prerequisite: Approval of instructor.

629. Educational Programming for the Gifted and Talented. (3-0). Credit 3. Theoretical issues confronting educators involved in program development for gifted and talented children and adolescents; analysis of educational perspectives and instructional implications. Prerequisite: Graduate classification.

636. Techniques of Research. (3-0). Credit 3. Fundamental concepts and tools of research applied to psychological and educational problems. Rationale of research, analysis of problems, library skills, sampling, appraisal instruments, statistical description and inference, writing the research report and representative research designs.

637. Experimental Design in Education. (3-0). Credit 3. Preparation in experimental research design in educational studies; application of statistical methods in these designs. Prerequisites: EPSY 636 or equivalent and three hours of statistics; EPSY 682 or equivalent computer competence.

646. Issues in Child and Adolescent Development. (3-0). Credit 3. Theoretical orientations, issues, research strategies and empirical findings of developmental psychology relevant to education. Prerequisite: PSYC 634 or equivalent.

650. Professional Standards and Issues in Psychology. (3-0). Credit 3. Issues, ethics and standards in professional psychology intended for beginning Ph.D. students; legal and professional guidelines in research, teaching and service delivery. Prerequisite: Graduate classification in educational psychology or psychology.

659. Practicum in Gifted and Talented Education. (1-6). Credit 3. Theory and strategies for instruction and guidance of the gifted and talented through a supervised experience in a laboratory setting with gifted and talented children and/or adolescents. Prerequisite: Approval of the instructor.

665. Psychology of Career Development. (3-0). Credit 3. Historical concepts, foundations and present status of career development theory. Research, issues, practical applications and future projections of career development theory.

668. Early Childhood Behavioral Development. (3-0). Credit 3. Social and individual factors affecting child development from conception to age 6. Implications of developmental psychology for early childhood education. Observation and research will augment the theoretical framework.

669. The College Student. (3-0). Credit 3. Nature, needs and characteristics of American college students. Developmental tasks, peer group relations and impact of college environment on student development. Research from behavioral sciences.

670. Student Personnel Work in Higher Education. (3-0). Credit 3. Survey of student personnel services in higher education; principles, philosophy and major theoretical issues. Organization and administration of specialty areas.

673. Learning Theories. (3-0). Credit 3. Comprehensive study of classical and current learning theories; their significance to modern education.

674. Verbal Learning and Verbal Behavior. (3-0). Credit 3. Current theory and research in verbal processes in children and adults. Variables influencing verbal learning. Application of research findings to educational programs involving verbal learning. Prerequisites: EPSY 673; approval of instructor.

682. Seminar in . . . (1-0). Credit 1. Knowledge, skills and attitudes in special education, counseling, psychological foundations of education and school psychology. Specific topics are announced for each seminar offered. May be taken more than once but not to exceed 6 hours of credit.

683. Field Practicum in . . . Credit 1 to 15. Supervised experience in professional employment settings in educational psychology. Wide range of practical experiences and activities as listed below that are closely supervised by departmental faculty. Repeatable to fifteen hours total. Prerequisite: Approval of instructor.

a — Special Education
b — Educational Assessment
c — Instructional Psychology
d — Applied Research
e — Gifted and Talented Education

684. Professional Internship. Credit 1 to 4 each semester. Limited to advanced doctoral students. University-directed experience in a professional employment setting. Full-time participation and responsibility in experiences related to career specializations in counseling or school psychology. Repeatable to 9 hours total. Prerequisite: Approval of department head six weeks prior to registration.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of educational psychology. May be repeated for credit.

690. Theory of Educational Psychology Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of educational psychology. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study or project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

COUNSELING PSYCHOLOGY
(CPSY)

630. Foundations of Counseling. (3-0). Credit 3. Philosophical, psychological and sociological concepts fundamental to counseling and related helping professions.

631. Techniques of Counseling. (3-0). Credit 3. Methods and procedures descriptive of the counseling process. Dynamics of counselor-counselee relationship. Interviewing techniques. Use of test results in counseling. Prerequisite: CPSY 630.

632. Career Counseling. (3-0). Credit 3. Theories of career development; sources, classification and analysis of educational, occupational and social information including occupational trends, post-secondary programs and financial planning; use of occupational-educational information, appropriate psychological measures and computerized guidance systems.

633. Introduction to Group Process. (2-3). Credit 3. Principles, procedures and processes of group approaches to assisting individuals in their personal growth and development in educational settings. Participation as member of a personal growth group required. Prerequisite: CPSY 630.

634. Group Counseling and Psychotherapy. (3-0). Credit 3. Major contemporary approaches to group counseling and psychotherapy. Experiential learning in a simulated group process. Integration of theory and practical applications. Prerequisites: CPSY 631 and 633 or equivalent.

635. Practicum in Group Counseling and Psychotherapy. Credit 1 to 4. Supervised practice in application of group counseling strategies and methods to client types and social environments appropriate to the professional interests of counseling psychologists. Prerequisites: CPSY 639, 633, 634 and application six weeks prior to registration.

639. Counseling Practicum I. (2-3). Credit 3. Supervised experience in individual counseling. Cases assigned in the counseling laboratory on campus. Off-campus counseling in schools and various agencies also assigned at supervisor's discretion. Prerequisites: CPSY 631 and 632; approval of instructor six weeks prior to registration.

662. Issues and Trends in Counseling Psychology. (3-0). Credit 3. Recent research and developments affecting counseling psychology as a profession. Ethical considerations, professional relationships, emerging trends and issues.

664. Counseling Practicum II. (1-6). Credit 3. Supervised experience in individual and group counseling requiring advanced technical skills. Continuing counseling relationships with various, selected subjects. Prerequisites: CPSY 639; approval of department head six weeks prior to registration.

666. Practicum in Counselor Supervision. (1-6). Credit 3. Supervised experience in directing counseling and guidance activities of students involved in practicum and field experiences. Intended for individuals preparing to become counselor educators or supervisors. Prerequisites: CPSY 664, approval of department head and application six weeks prior to registration.

672. Theories of Counseling and Psychotherapy. (3-0). Credit 3. Comprehensive and intensive study of major theoretical positions in counseling and psychotherapy; implications for research and practice. Prerequisite: CPSY 631.

675. Seminar in Counseling Psychology. (3-0). Credit 3. Intensive consideration of topics pertinent to professional activities of counseling psychologists. Ethical and legal considerations, emerging techniques, and program management. Prerequisites: CPSY 664, 672 and approval of instructor.

676. Marriage and Family Counseling. (3-0). Credit 3. Basic concepts and techniques in marriage and family counseling. Marital communication and growth relationships. Prerequisites: CPSY 631, 633 and approval of instructor.

677. Practicum in Counseling Older Adults. (1-6). Credit 3. Practicum in theory and strategies for providing mental health services to the elderly. Training and supervision of individual counseling and community mental health approaches in a variety of settings. Prerequisites: Human service experience and approval of instructor.

678. Marital Therapy. (3-0). Credit 3. Theory and practice of marital therapy emphasizing systems and communication approaches; effective strategies and techniques; therapy with specific marital problems, and obstacles to effective therapy. Prerequisites: CPSY 631 and 639 or equivalent and approval of instructor.

679. Multicultural Counseling. (3-0) Credit 3. Effective communication skills in cross-cultural counseling or helping relationships; integration of theoretical knowledge with experiential learning; psychosocial factors and lifestyles of cultural groups; effect on counseling relationships. Prerequisite: Graduate standing.

683. Field Practicum in . . . Credit 1 to 15. Faculty supervised experience in professional practice settings in counseling psychology. Repeatable to 15 hours total. Prerequisite: CPSY 639.

a — Counseling Psychology
b — Guidance
c — Marital and Family Therapy
d — Psychological Assessment
e — Hypnotherapy
f — Psychotherapeutic Process
g — Career Counseling
h — Biofeedback
i — Group Therapy

684. Professional Internship. Credit 1 to 4 each semester. Limited to advanced doctoral students. Faculty supervised experience in approved professional employment settings. Applications for September assignments must be approved the previous October. Repeatable to 9 hours total. Prerequisite: Completion of required course work except CPSY 684 and 691.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4 each semester. Selected topic in an identified area of counseling psychology. May be repeated for credit.

690. Theory of Counseling Psychology Research. (3-0). Credit 3. Theory and design of research problems and experiments in counseling psychology. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

SCHOOL PSYCHOLOGY
(SPSY)

612. Individual Assessment of Children's Intelligence. (3-0). Credit 3. Educational and clinical applications of individual assessment; diagnostic measures of intelligence, language abilities, perception and achievement; video-taping of student test administration is required for purposes of supervision and self-evaluation. Limited to 12 students per semester. Prerequisites: EPSY 622, PSYC 624; approval of department head.

614. Laboratory in Intellectual Assessment and Diagnosis. (1-6). Credit 3. Student test administration competencies and a minimum of 150 hours of supervised experience in administration, analysis and reporting of individual diagnostic instruments. Prerequisite: To be taken concurrently with SPSY 612.

615. Individual Assessment of Preschool Children. (3-2). Credit 4. Theory and techniques of psychological and developmental assessment of children from 2½ to 8½ years: specific skills for assessment developed; practice in preparing psychological reports. Prerequisites: SPSY 612 and 614 or equivalents.

617. Diagnosis of Emotionally Disturbed Children. (3-0). Credit 3. Diagnostic procedures and techniques in personality assessment and identification of emotionally disturbed children and youth.

628. Consultation: Theory and Techniques. (3-0). Credit 3. History and theory of various models of consultation including mental health, behavioral and organizational development. Skills and techniques necessary for effective consultation. Relevant research issues. Prerequisites: SPSY 618; SPSY 612, 614 or approval of instructor.

640. Practicum in Consultation. (0-10). Credit 3. Supervised practice in the application of consultation strategies and techniques in mental health, behavioral and organizational development consultation in a variety of settings. Off-campus consultation with schools and other agencies. Prerequisites: SPSY 628 and approval of instructor.

641. Child Therapy for School Behavior Problems. (3-0). Credit 3. Selected therapy approaches for treating childhood behavioral disorders that interfere with children's interpersonal and intrapersonal adjustment and school learning; play therapy, behavior therapy, cognitive therapies; case studies; observation of therapy cases. Prerequisite: PSYC 628.

683. Field Practicum in . . . Credit 1 to 15. Faculty supervised experience in professional employment settings in school psychology. Repeatable to 15 hours total.

a — Assessment
b — School Psychology

684. Professional Internship. Credit 1 to 4 each semester. Limited to advanced doctoral students. Faculty supervised experience in approved professional employment settings. Applications for September assignments must be approved the previous October. Repeatable to 9 hours. Prerequisites: Completion of required substantive course work.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of school psychology. May be repeated for credit.

690. Theory of School Psychology Research. (3-0). Credit 4. Theory and design of research problems and experiments in school psychology. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

SPECIAL EDUCATION (SPED)

608. Psychosocial Variables in Special Education. (3-0). Credit 3. Social and personality characteristics of pupils in special education settings. Relevant research and theories. Implications for future educational practice and research. Prerequisite: SPED 610 or equivalent.

610. The Exceptional Child. (3-0). Credit 3. Exceptional and handicapped individuals: identification, characteristics, remedial and treatment programs. Implications for educational intervention for regular and special educators.

611. Learning Characteristics of Exceptional Children. (3-0). Credit 3. Learning behavior of exceptional children. Educational, psychological and medical information relevant to the learning-disabled in public schools. Educationally relevant conceptual models.

613. Individualized Teaching of Exceptional Children. (3-0). Credit 3. Teaching strategies for exceptional children. Management of educational data on individual pupils. Collection, analysis, teacher interpretation of data and formulation of recommendations for educational change. Prerequisite: SPED 610, 611, or approval of department head.

615. Individual Instruction Programming. (1-6). Credit 3. Laboratory experiences in developing prescriptions for individual teaching of learning-disabled children. Translation of diagnostic test results into programs of individual instruction. Prerequisite: SPED 613.

617. Contemporary Instructional Approaches for Handicapped Pupils. (3-0). Credit 3. Principles in individualizing instuction for improving the learning efficiency of handicapped pupils; issues relating to mastery learning, direct instruction, cognitive behavior modification, cooperative learning and other approaches utilized with handicapped pupils. Prerequisite: SPED 610.

VOCATIONAL EDUCATION (VOED)

601. Principles and Practices of Vocational Education. (3-0). Credit 3. Principles of vocational education, its development, social and economic values, and purposes. Contemporary practices, regulations, scope and nature of the program components of vocational education.

605. Organization and Administration of Vocational Education. (3-0). Credit 3. Administration of comprehensive vocational education programs; operation and implementation of programs as provided for by state and federal legislation.

611. Vocational Student Identification, Placement, and Follow-up. (3-0). Credit 3. Various instruments, methods and techniques used in determining occupational aptitudes and interests of students. Planning, organizing and coordinating placement and follow-up programs.

612. Planning and Organizing Programs of Vocational Guidance. (3-0). Credit 3. Purposes and functions of a guidance program; group guidance procedures; components of a vocational guidance program; techniques of providing vocational guidance services for elementary and secondary students and adults.

615. Developing Curricula in Vocational Education. (3-0). Credit 3. Principles and applied practices in developing curricula for different areas of vocational education. Process of curricular development and improvement using a systems approach.

617. Vocational Cooperative Training Programs. (3-0). Credit 3. Implementation of standards for cooperative training programs; organization and coordination of cooperative education programs; development and maintenance of required records in cooperative education; correlation of related studies and on-the-job training activities; public relations activities and youth leadership development activities.

620. Evaluation and Analysis in Vocational Education. (2-2). Credit 3. Principles and procedures of evaluation used in developing and conducting programs of vocational education. Field practice in evaluation procedures required.

622. Vocational Education for the Special Needs Student. (3-0). Credit 3. For vocational and special education teachers, administrators and support personnel who are involved in educating the handicapped at the secondary level. Current issues and practices pertaining to career preparation of the handicapped from a vocational and special needs perspective. Field trips required for which departmental fee may be assessed to cover costs. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research, contemporary trends and professional issues in vocational education. May be repeated for credit. Prerequisite: Approval of instructor.

683. Field Practicum in . . . Credit 1 to 15. Supervised experience in professional employment in vocational education. Repeatable to 15 hours total. Prerequisite: Approval of instructor.

684. Professional Internship. Credit 1 to 6 each semester. Supervised experience in performing professional functions appropriate to career goals in vocational education. Prerequisite: Approval of department head prior to registration.

685. Problems. Credit 1 to 4 each semester. Directed individual study of related problems. Prerequisite: Approval of department head prior to registration.

689. Special Topics in . . . Credit 1 to 4 each semester. Selected topics in an identified area of vocational education. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Vocational Education Research. (3-0). Credit 3. Theory and design of research problems in vocational education; communication of research proposals and results; evaluation of current research of faculty and students; review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for dissertation. Prerequisite: Approval of major advisor.

692. Professional Study. Credit 1 or more each semester. Approved professional study of projects undertaken as the terminal requirement for doctor of education degree; preparation of a record of study summarizing the rationale, procedures and results of the completed projects. Prerequisite: Approval of major advisor.

EDUCATIONAL TECHNOLOGY

(See Interdisciplinary Education)

DEPARTMENT OF ELECTRICAL ENGINEERING

H. Abu-Amara, A. Abur, S. P. Bhattacharyya, W. G. Bliss, P. E. Cantrell, A. K. Chan, K. Chang, U. Cilingiroglu, M. Dahleh, A.-C. Deng, M. Ehsani, O. Eknoyan, P. Enjeti, T. R. Fischer, R. L. Geiger, C. Georghiades, J. D. Gibson, N. C. Griswold, D. R. Halverson, J. W. Howze (Head), G. M. Huang, W. B. Jones, Jr., N. Kehtarnavaz, Y.-Y. Leung, S. Li, M. Lu, K. A. Michalski, R. D. Nevels, P. S. Noe, J. H. Painter, R. K. Pandey, D. L. Parker, A. D. Patton, J. Ramirez-Angulo, B. D. Russell, E. Sanchez-Sinencio, C. Singh*, M. A. Styblinski, C. B. Su, H. F. Taylor, W. K. Tsai, P. Van Peteghem, K. L. Watson, M. H. Weichold, S. M. Wright, B. D. Young

*Graduate Advisor

The Department of Electrical Engineering offers programs for graduate study leading to the research-oriented master of science and doctor of philosophy degrees and to the professional master of engineering degree. Courses in the department may also be applied to the interdisciplinary doctor of engineering degree. The M.S. and Ph.D. programs provide specialization in-depth and include a research (thesis or dissertation) requirement. The M.Eng. and D.Eng. programs are designed to provide the depth and breadth necessary for the practice of engineering at advanced levels.

Current areas of study include digital systems and computers, communications, controls, linear and nonlinear systems theory, digital signal processing, solid state electronics, analog circuits, power, electromagnetics, electrotropics and instrumentation systems. Interdisciplinary engineering programs are available in other areas.

Well equipped laboratories are available for work in all of these areas. Special laboratory facilities are available to graduate students in solid-state electronics, integrated circuit design, electromagnetics, microwave microelectronics, electrotropics, computer vision and electric power systems. A DEC VAX 11/785 computer and other mini- and micro-computers are available for computer aided design, digital signal processing and other research programs.

There is no foreign language requirement for the Ph.D. or D.Eng. programs in electrical engineering.

(ELEN)

601. Linear Network Analysis. (3-0). Credit 3. Signal theory treatment of continuous and discrete signals and systems. Vector spaces, projection and sampling theories, Fourier, Laplace and Z Transforms.

602. Computer Communication and Networking (3-0). Credit 3. Computer communication and computer networks; use of the International Standards Organization (ISO) seven layer Open Systems Interconnection model as basis for systematic approach; operational networks to be included in the study of each layer; homework assignments to make use of a campus computer network. Prerequisite: ELEN 646 or equivalent probability background.

605. Linear Control Systems. (3-3). Credit 4. Application of state variable and complex frequency domain techniques to analysis and synthesis of multivariable control systems. Prerequisite: ELEN 420 or equivalent.

606. Nonlinear Control Systems. (3-0). Credit 3. Techniques available to analyze and synthesize nonlinear and discontinuous control systems. Modern stability theory, time-varying systems, DF, DIDF, Lyapunov Theory, adaptive control, identification and design principles for using these concepts. Examples are drawn from a variety of electronic and electromechanical systems. Prerequisite: ELEN 605.

615. Methods of Electric Power Systems Analysis. (3-0). Credit 3. Digital computer methods for solution of the load flow problem. Load flow approximations. Equivalents. Optimal load flow. Prerequisite: ELEN 460 or approval of instructor.

617. Advanced Data Communication Networks. (3-0). Credit 3. Advanced concepts and analysis of control of data and computer communication networks; develops and studies analytically communication network models, optimal and adaptive routing, optimal quasi-static routing methods, dynamic routing, multi-access schemes, local networks, packet radio networks and flow control algorithms. Prerequisite: ELEN 602 or CPSC 619. Cross-listed with CPSC 617.

620. Network Theory. (3-0). Credit 3. Development and application of advanced topics in circuit analysis and synthesis in both the continuous and discrete time and frequency domains. Prerequisites: ELEN 323 and 326 or equivalent.

622. Active Network Synthesis. (3-0). Credit 3. Methods of analyzing and synthesizing active networks. Sensitivity analysis, methods of rational fraction approximation, OP AMP modeling and stability. Prerequisite: ELEN 457 or equivalent.

626. Analog Circuit Design. (3-0). Credit 3. Principles of designing analog circuits suitable for integrated circuit fabrication. Fabrication techniques from a designer's viewpoint; student will design and build on a multichip basis an actual integrated circuit of own design. Circuit modeling and analysis. Prerequisites: ELEN 326 and 457 or equivalent.

628. Linear System Theory. (3-0). Credit 3. Application of functional analysis and geometric concepts to the analysis and synthesis of control systems. Prerequisite: ELEN 605.

630. Analysis of Power Electronic Systems. (3-0). Credit 3. Analysis and control of semiconductor switching power converters using specialized methods such as Fourier series, state-space averaging, time domain transfer functions, sliding mode, quadrometrics and other discontinuous orthogonal functions; application of the above techniques in practice; selected research publications. Prerequisite: Approval of instructor.

632. Motor Drive Dynamics. (3-0). Credit 3. Mathematical analysis of adjustable speed motor drive dynamics; direct torque control in dc and ac machines; the theory of field orientation and vector control in high preformance ac motor drives; motion control strategies based on the above theories; microcomputer, signal and power circuit implementation concepts. Prerequisite: Approval of instructor.

633. Optimum Control Systems. (3-0). Credit 3. Variational approach to the development of algorithms for the solution of optimum control problems. Necessary and sufficient conditions, numerical methods, and analysis and comparison of optimal control results to classical theory. Prerequisite: ELEN 605.

635. Electromagnetic Theory. (3-0). Credit 3. Maxwell's equations, boundary conditions, Poynting's theorem, electromagnetic potentials, Green's functions, Helmholtz's equation, field equivalence theorems; applications to problems involving transmission scattering and diffraction of electromagnetic waves. Prerequisites: ELEN 322 and 351 or equivalent.

638. Antennas and Propagation. (3-0). Credit 3. Application of Maxwell's equations to determine electromagnetic fields of antennas. Radiation, directional arrays, impedance characteristics, aperture antennas. Prerequisite: ELEN 351.

639. Microwave Circuits. (3-0). Credit 3. Introduction to high frequency systems and circuits. Provides background information needed to understand fundamentals of microwave integrated circuits. Includes usage of S-parameters, Smith Charts, stability considerations in designing microwave circuits. Utilizes CAD program "Super Compact" demonstrating design synthesis optimization and analysis of monolithic devices and circuits. Prerequisite: Graduate classification.

640. Wave Optics and Optical Waveguides. (3-0). Credit 3. Maxwell's equations; wave optics; theory of diffraction; ray optics; Gaussian Beams; propagation in square law media; optical slab waveguides; optical fibers; coupling between waveguides. Prerequisites: ELEN 635 and MATH 601.

643. Electric Power System Reliability. (3-0). Credit 3. Design and application of mathematical models for estimating various measures of reliability in electric power systems. Prerequisite: ELEN 460 or approval of instructor.

644. Discrete-Time Systems. (3-0). Credit 3. Linear discrete time systems analysis using time domain and transform approaches. Digital filter design techniques with digital computer implementations. Prerequisite: ELEN 601.

646. Statistical Communication Theory. (3-0). Credit 3. Concepts of probability and random process theory necessary for advanced study of communications, stochastic control and other electrical engineering problems involving uncertainty. Applications to elementary detection and estimation problems. Prerequisite: Registration in ELEN 601 or approval of instructor.

647. Information Theory. (3-0). Credit 3. Definition of information; coding of information for transmission over a noisy channel including additive gaussian noise channels and waveform channels; minimum rates at which sources can be encoded; maximum rates at which information can be transmitted over noisy channels. Prerequisite: ELEN 646 or equivalent probability background.

649. Pattern Recognition. (3-0). Credit 3. Introduction to the underlying principles of classification, and computer recognition of imagery and robotic applications. Prerequisites: MATH 601 and/or STAT 601 and approval of instructor.

650. Control of Dynamic Stochastic Systems. (3-0). Credit 3. Optimum stochastic control, estimation and identification techniques with application to communication and control systems. Dynamic programming algorithms developed for the control of uncertain dynamic systems. Kalman filtering algorithms developed in the context of state estimation for dynamic stochastic systems. Prerequisites: ELEN 646, 605.

651. Microprogrammed Control of Digital Systems. (3-3). Credit 4. Hardware and software concepts involved in the design and construction of microprocessor-based digital systems. Microprocessor architecture; bussing; interfacing; data input/output; memories; and software development for operation and testing. Design projects with microprocessors and related components. Prerequisite: ELEN 348 or approval of instructor.

652. Digital Systems Design. (3-3). Credit 4. Digital systems design; synchronous sequential machines, iterative networks, fast tabular minimization algorithms, state reduction, state assignment optimization, partition theory and incompletely specified machines. Practical case studies in digital systems design in the laboratory emphasize individual effort in the use of hardware (or software) applications for practical real-world problems.

653. Computer Arithmetic Unit Design. (3-0). Credit 3. Digital computer arithmetic unit design, control and memory; microprocessor arithmetic logic unit (ALU) design. High-speed addition, subtraction, multiplication and division algorithms and implementations. Design and simulation with integrated circuit components and VLSI circuits. Prerequisite: ELEN 651.

654. Very Large Scale Integrated Systems Design. (3-0). Credit 3. Design and fabrication of microelectronic circuits such as registers, selectors, PLA's, sequential and microprogrammed machines via large scale integrated circuitry with emphasis on high-level, structured design methods for VLSI systems. Students design small to medium scale integrated circuits for fabrication by industry. Prerequisites: ELEN 326 and 449.

655. Asynchronous Switching Circuit Design. (3-0). Credit 3. Design of asynchronous sequential switching circuits; primitive flow-tables, state reduction, state assignment, hazards and delay. Relationship of asynchronous to synchronous digital systems; the need for race-free assignments in asynchronous design. Prerequisite: ELEN 348 or equivalent.

656. Physical Electronics. (3-0). Credit 3. Elementary quantum theory. Statistical mechanics. Lattice dynamics. Semiconductor theory. Dielectrics. Magnetic materials. Quantum electronics. Introduction to quantum devices, such as the laser. Prerequisite: Graduate classification or approval of instructor.

657. Quantum Electronics. (3-0). Credit 3. Application of principles of quantum mechanics to problems in optics including emission, absorption and amplification of light; optical resonators and lasers; optical modulation; nonlinear optics; photodetectors and optical receivers. Prerequisites: PHYS 412, PHYS 606 or approval of instructor.

659. Parallel/Distributed Numerical Algorithms and Applications. (3-0). Credit 3. A unified treatment of parallel and distributed numerical algorithms; parallel and distributed computation models, parallel computation or arithmetic expressions; fast algorithms for numerical linear algebra, partial differential equations and nonlinear optimization. Prerequisite: MATH 304 or equivalent. Cross-listed with CPSC 659.

661. Modulation Theory. (3-0). Credit 3. Optimum receiver principles and signal selection for communication systems with and without coding; system implementation, and waveform communication using realistic channel models. Prerequisite: ELEN 646.

662. Estimation and Detection Theory. (3-0). Credit 3. Probabilistic signal detection theory and parameter estimation theory. Neyman-Pearson, UMP, and locally optimal tests. Discrete time Markov processes and the Kalman and Wiener filters. Bayesian, maximum likelihood and conditional mean estimation methods. Prerequisite: ELEN 646.

663. Data Compression with Applications to Speech and Video. (3-0). Credit 3. Characterization and representation of waveforms; digital coding of waveforms including PCM, delta modulation, DPCM, tree/trellis coding, runlength coding, sub-band coding and transform coding. Rate distortion theoretic performance bounds. Prerequisites: ELEN 601, 646.

666. Power System Faults and Protective Relaying. (3-0). Credit 3. Calculation of power system currents and voltages during faults. Protective relaying principles, application and response to system faults. Prerequisite: ELEN 460 or approval of instructor.

667. Power System Stability. (3-0). Credit 3. Steady-state, dynamic and transient stability of power systems. Solution techniques. Effect of generator control systems. Prerequisite: ELEN 460 or approval of instructor.

668. High Voltage Direct Current (HVDC) Transmission. (3-0). Credit 3. Overview of HVDC systems; comparison of AC and DC power transmission; study of six-pulse and twelve-pulse power converters; analysis and control of HVDC systems; harmonics and power factor effects; system faults and misoperations; state of the art and future developments in HVDC technology; inspection trips. Prerequisite: Approval of instructor.

671. Solid State Devices. (3-0). Credit 3. Development of mathematical analysis and systematic modeling of solid state devices. Relationships of measurable electrical characteristics to morphology and material properties of solid state devices, p-n junction, bipolar and unipolar transistors. Prerequisite: ELEN 656 or approval of instructor.

673. Fundamentals of Microelectronics. (3-0). Credit 3. Microelectronic systems and fabrication technologies; methods of engineering analysis and device characterization. Junction diodes, Schottky diodes, bipolar transistors, junction and MOS field-effect devices, solar cells, light emitting diodes, charge coupled devices, magnetic bubbles, liquid crystal displays, and other newly developed devices and circuits. Prerequisite: Graduate classification or approval of instructor.

677. Control of Electric Power Systems. (3-0). Credit 3. Modeling, analysis and real-time control of electric power systems to meet the requirements of economic dispatch of voltage and power. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program nor twice in Ph.D. program. Prerequisite: Graduate classification in electrical engineering.

684. Professional Internship. Credit 1 to 4. Engineering research and design experience at industrial facilities away from the Texas A&M campus. Design projects supervised by faculty coordinators and personnel at these locations. Projects selected to match student's area of specialization. Prerequisites: Graduate classification and one semester of course work completed.

685. Problems. Credit 1 to 4 each semester. Research problems of limited scope designed primarily to develop research technique.

689. Special Topics in . . . Credit 1 to 4. Advanced topics of current interest in electrical engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

ENGINEERING
(ENGR)

604. Industrial Communications and Training Systems. (2-2). Credit 3. Industrial communications techniques; development of industrial survey research, conference and committee programs, large and small group presentations, in-house bulletins, industrial employee training programs and other operating communications procedures. Prerequisite: ENTC 404 or approval of department head.

681. Professional Development Seminar. (1-0). Credit 1. Topics of interest related to the professional practice of engineering.

684. Professional Internship. Credit 1 or more each semester. Supervised experience of one academic year in industry where students can learn to apply their textbook-based skills to problems in the real-world environment. Prerequisites: Admission to the doctor of engineering program and graduate classification.

690. Theory of Engineering Research. (3-0). Credit 3. Theory, design, analysis and communication of research in various engineering fields. Evaluation of research results with the aid of examples from current engineering literature and from ongoing research within the college. May be repeated for credit.

DEPARTMENT OF ENGLISH

D. R. Anderson, H. Andreadis, S. L. Archer, G. H. Bailey, V. M. Balester, R. W. Barzak, D. A. Berthold*, R. E. Boenig, F. D. Burt, M. B. Busby*, R. E. Campbell, G. H. Cannon, P. C. Christensen, R. E. Clark, W. B. Clark, R. H. Costa, J. N. Cox, T. W. Crusius, D. R. Dickson*, D. Dowdey, S. A. Dragga, E. M. Eldridge, M. J. M. Ezell, K. W. Ferrara, C. L. Gibson, G. Gong, J. R. Goodman*, T. A. Green, J. L. Harner, H. L. Hill (Head), T. A. Hoagwood, P. C. Hunter, Jr., B. Johnstone, C. W. Kallendorf, K. E. Kelly, H. P. Kroitor, J. M. Loving, C. J. Machann, J. P. McCann, H. T. Meserole, R. D. Newman*, K. O'B. O'Keeffe, L. J. Oliver, P. A. Parrish, K. M. Price, L. J. Reynolds, C. E. Schatte, D. H. Stewart, J. P. Stout, E. D. Tebeaux, J. E. Van Domelen*, E. C. Want, Jr., S. R. Yarbrough

*Graduate Advisor

The graduate program in English offers courses leading to the degrees of master of arts and doctor of philosophy. Graduate study increases understanding and appreciation of English and American literature, provides training in techniques of critical investigation, broadens understanding of the English language, and enhances skill in the use of the language. Graduate work in English prepares students primarily for teaching in schools, community colleges, and universities. It can also prepare them for careers in linguistics, writing, editing, and other professional and business fields.

Both the M.A. degree (thesis option) and the M.A. degree (non-thesis option) require ENGL 603. In addition, the thesis option requires nine hours of course work in literature, and the non-thesis option requires 12 hours of course work in literature. The thesis may be written on a subject in English literature, American literature, linguistics, rhetoric and composition, or creative writing.

A minimum of 64 credit hours beyond the M.A., or 96 hours beyond the B.A., is required for the Ph.D. degree in English. The student's program may include a minor of up to 12 hours. The dissertation may be written on a subject in English literature, American literature, linguistics, or rhetoric and composition.

To be admitted to either program, a student should have a baccalaureate degree and should gain admission to graduate studies. Students who hold baccalaureate degrees in fields other than English may be admitted provisionally and required to make up deficiencies. A Ph.D. candidate will normally be expected to hold the M.A. degree.

A student may meet the Ph.D. language requirement by demonstrating comprehensive knowledge of one language, or reading knowledge of two languages, or reading knowledge of one language plus six hours of course work assigned by the student's committee.

ENGLISH
(ENGL)

603. Bibliography and Literary Research. (3-0). Credit 3. Introduction of basic techniques of research and scholarly procedure in literature. Research reports.

605. Old English. (3-0). Credit 3. Introduction to Old English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers. Cross-listed with LING 605. Credit cannot be given for both ENGL 605 and LING 605.

606. Beowulf. (3-0). Credit 3. Literary and linguistic study of Beowulf. Prerequisites: ENGL 605, LING 610; or approval of instructor. Cross-listed with LING 606. Credit cannot be given for both ENGL 606 and LING 606.

609. Non-Chaucerian Middle English. (3-0). Credit 3. Non-Chaucerian Middle English literature and language including the Morte Dárthur and the Arthurian Romances, the Fabliaux, Piers Plowman, the Pearl Poet, Mystery plays, the English and Scots Chaucerians, and others. Related topics may include medieval rhetorical theory, linguistic profile of Middle English, paleography, manuscript classification, and research techniques. Prerequisites: Graduate classification and approval of instructor. Cross-listed with LING 609. Credit cannot be given for both ENGL 609 and LING 609.

610. History of the English Language. (3-0). Credit 3. Inductive study of phonological, grammatical, and lexical history of English language, with brief discussion of some other Indo-European languages; kinds and principles of linguistic changes in general, as reflected in English. Prerequisite: ENGL 662 or approval of instructor. Cross-listed with LING 610. Credit cannot be given for both ENGL 610 and LING 610.

612. Chaucer. (3-0). Credit 3. A literary and linguistic study of Chaucer's works. Bibliographical reports and research papers. Cross-listed with LING 612. Credit cannot be given for both ENGL 612 and LING 612.

613. Studies in the Renaissance. (3-0). Credit 3. Drama of the English Renaissance, exclusive of Shakespeare. Research papers.

614. Studies in the Renaissance: Nondramatic Literature. (3-0). Credit 3. Major writers of nondramatic prose and poetry of the English Renaissance.

615. Seventeenth Century English Literature. (3-0). Credit 3. Poetry and prose of chief writers of 17th century: Bacon, Donne, Jonson, Herrick, Milton, and Dryden. Research papers.

616. Studies in the Eighteenth Century: The Age of Pope. (3-0). Credit 3. Poetry and prose to 1750 concentrating on Defoe, Addison, Swift, Pope, and Smollett; aesthetic, scientific, and religious ideas. Research papers.

617. Studies in the Eighteenth Century: The Age of Johnson. (3-0). Credit 3. Prose, including the novel, in latter half of century concentrating on Fielding, Johnson, Boswell, Goldsmith, and Sterne; aesthetic, scientific, and philosophic ideas. Research papers.

619. Studies in Shakespeare. (3-0). Credit 3. Readings in Shakespeare's plays with attention to requirements and needs of individual students; sources of plays; textual studies; parallel readings in Shakespearean criticism from 18th century to present. Research papers. Prerequisite: A course in Shakespeare.

620. Business Communication. (1-0). Credit 1. Techniques for effective use of oral and written communication in business. Written elements and applications; purposes, preparation sequences and delivery skills of oral presentations. Classification 6 students may not enroll in this course. Prerequisite: Approval of instructor. Cross-listed with BUAD 620.

621. Milton and His Contemporaries. (3-0). Credit 3. Poetry and prose of John Milton with emphasis on *Paradise Lost*. Milton's predecessors and contemporaries as they contribute to understanding the milieu of Milton. Research papers.

625. Business Communication. (2-0). Credit 2. Focusing upon the process of designing written business communications; insight into the rhetorical strategies necessary for developing effective business communication. Cross-listed with BUAD 625.

629. Seminar in Literature, Language, or Rhetoric. (3-0). Credit 3. Intensive investigation of a topic important to the understanding of British or American literature, or of language or rhetoric. May be repeated for credit up to a total of three times. Prerequisite: Approval of instructor.

631. Studies in the Nineteenth Century: Earlier Romantics. (3-0). Credit 3. The major earlier Romantic writers of poetry and prose with concentration on two or three authors each time course is offered. Representative authors: Blake, Wordsworth, Coleridge, Lamb, Hazlitt. Research papers.

633. Studies in the Nineteenth Century: Later Romantics. (3-0). Credit 3. The major later Romantic writers of poetry and prose with concentration on two or three authors each time the course is offered. Representative authors: Byron, Shelley, Keats, DeQuincey. Research papers.

634. Studies in the Nineteenth Century: The Victorian Age. (3-0). Credit 3. Prose and poetry from Carlyle to Shaw. Research papers.

635. Studies in Victorian Poetry and Prose. (3-0). Credit 3. Major Victorian writers of poetry and nonfiction prose with concentration on two or three authors each time the course is offered. Representative authors: Tennyson, Browning, Rossetti, Morris, Swinburne, Arnold, Carlyle, Ruskin, Mill, Newman, Pater, Shaw. Research papers.

641. Studies in the English Novel. (3-0). Credit 3. Major English novelists from 1740 to 20th century. Analysis of eight to ten novels — style, characterization, plot, atmosphere, and social commentary — against their intellectual, historical, and social backgrounds. Research paper.

647. Studies in Modern British Drama. (3-0). Credit 3. Dramatic literature of British Isles from 1880's to present with some consideration of influence from the Continent. Representative dramatists: Wilde, Shaw, Pinero, Maugham, Synge, O'Casey, Eliot, Fry. Research papers.

649. Studies in the Twentieth Century: British Literature. (3-0). Credit 3. Selected authors since 1900: Yeats, Joyce, Huxley, and others. Development of particular literary movement or literary form. Research papers.

650. Studies in the Twentieth Century: American Literature. (3-0). Credit 3. Selected authors since 1900: Robinson, Frost, Eliot, Lewis, Faulkner, Hemingway, and others. Particular literary movement or literary form. Research papers.

651. Southwestern Literature. (3-0). Credit 3. Readings in Southwestern literature, with particular emphasis on literature that reflects the various cultures — Anglo-American, Mexican-American, and Native American — of the area.

652. Studies in Postmodernism. (3-0). Credit 3. Selected literary works since World War II with an emphasis on postmodern themes and experiments with form. Prerequisite: Graduate classification.

654. History of Rhetoric to 1900. (3-0). Credit 3. Key concepts of rhetoric, surveying primary authors and works from 5th century Greece to the 19th century.

655. Modern Rhetorical Theories. (3-0). Credit 3. Works of modern rhetorical theorists, including Burke, Richards, Ong, Moffet, Young, Christensen, Perelman, Kinneavy, and others; application and evaluation of these theories.

656. Contemporary Composition Theory.(3-0). Credit 3. Examines theories of the composing process and the relation of language study to composition; explores contributions by such theorists as Kinneavy, D'Angelo, Corbett, Moffett, Young, Lauer, Britton, Winterowd, and Shaughnessy.

657. The English Writing Lab. (2-2). Credit 3. The "Writing Lab" as a means of individualizing the teaching of writing; the four basic components of writing labs: administration, production, directed studies, and learning resources; analysis of the efficiency of various writing lab models. Prerequisites: Graduate classification; approval of instructor.

660. Technical Writing for Publications. (3-0). Credit 3. Organization, presentation, and style of reports and articles in professional journals. Article or articles of substantial length from the student's research are required.

661. Analysis of Composition. (3-0). Credit 3. Practice and theory in organization — sentence, paragraph, development of paper; rhetorical analysis of expository writing; diction, writing, and assigning compositions; teaching techniques.

662. Analysis of the English Language. (3-0). Credit 3. Phonological, morphological, syntactic, and lexical components of the English language; transformational theory as well as traditional and structural grammar. Cross-listed with LING 662. Credit cannot be given for both ENGL 662 and LING 662.

663. Analysis of Literature. (3-0). Credit 3. Characteristics of literature: point of view, structure, techniques of development, style and rhetorical devices, and theme and meaning. Types of literature: poetry, plays, novel, short story. Literary criticism: principles and application.

664. Analysis of Business and Technical Writing. (3-0). Credit 3. Theory of teaching business and technical writing. Evaluation of current research and its relation to current practice.

671. Studies in American Literature: The Beginnings to 1820. (3-0). Credit 3. Colonial, Revolutionary, and Post-Revolutionary literature and the backgrounds; various forms of early literature and individual writers. Research papers.

672. Studies in American Literature: The Literary Milieux of Poe, Hawthorne, and Melville. (3-0). Credit 3. Selected works of Poe, Hawthorne, Melville, and other writers and literary groups associated with American romanticism. Research papers.

674. Studies in American Literature: The Age of Transcendentalism. (3-0). Credit 3. Backgrounds of transcendentalism in Europe; the movement in the U.S.; works of Emerson, Whitman, Thoreau, and others. Research papers.

675. Studies in American Literature: The Gilded Age. (3-0). Credit 3. Social and literary backgrounds of Gilded Age; emergence of American humor and realism, and their development in Mark Twain and early Henry James. Research papers.

677. Studies in American Poetry. (3-0). Credit 3. Major American poets — for example, Edward Taylor, Poe, Whitman, Emily Dickinson, Robert Frost — and the influence of American poetry and American culture on each other. Research papers.

683. Theory and Practice of Literary Criticism. (3-0). Credit 3. Important theories of literary criticism for students of English and American literature; functional emphasis in critical practice. Research papers.

685. Problems. Credit 1 to 6 each semester. Readings to supplement the student's knowledge of English or American literature or of the English language in areas not studied in other courses. Research papers. Prerequisites: Graduate classification; approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of English. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. Research for thesis.

697. Seminar in the Teaching of English Composition. (3-0). Credit 3. Theory of teaching of college composition and rhetoric. Supervised teaching. Evaluation of current research and its relation to current practice. May be repeated for credit with three credit hours applying toward any degree.

LINGUISTICS
(LING)

602. Sociolinguistics. (3-0). Credit 3. Interrelationships between sociology and linguistics, especially the particular qualities of a given group's speech that help lead to social and economic barriers against that group; the role of language as chief vehicle of communication in a given sociological situation. Prerequisite: Approval of instructor.

605. Old English. (3-0). Credit 3. Introduction to Old English literature and language (phonology, morphology, syntax, lexicon, and dialectology) through extensive reading of the literature of the period. Research papers. Cross-listed with ENGL 605. Credit cannot be given for both ENGL 605 and LING 605.

606. Beowulf. (3-0). Credit 3. Literary and linguistic study of Beowulf. Prerequisites: ENGL 605, LING 610; or approval of instructor. Cross-listed with ENGL 606. Credit cannot be given for both ENGL 606 and LING 606.

608. General Linguistics: Syntax and Semantics. (3-0). Credit 3. Nature and structure of language; work in phonetics and phonemics, morphology, syntax, lexicography, and generative-transformational models. Prerequisite: Course in linguistics.

609. Non-Chaucerian Middle English. (3-0). Credit 3. Non-Chaucerian Middle English literature and language including the Morte Dárthur and the Arthurian Romances, the Fabliaux, Piers Plowman, the Pearl Poet, Mystery plays, the English and Scots Chaucerians, and others. Related topics may include medieval rhetorical theory, linguistic profile of Middle English, paleography, manuscript classification, and research techniques. Prerequisites: Graduate classification and approval of instructor. Cross-listed with ENGL 609. Credit cannot be given for both ENGL 609 and LING 609.

610. History of the English Language. (3-0). Credit 3. Inductive study of phonological, grammatical, and lexical history of English language, with brief discussion of some other Indo-European languages; kinds and principles of linguistic changes in general, as reflected in English. Prerequisite: ENGL 662 or approval of instructor. Cross-listed with ENGL 610. Credit cannot be given for both ENGL 610 and LING 610.

612. Chaucer. (3-0). Credit 3. A literary and linguistic study of Chaucer's works. Bibliographical reports and research papers. Cross-listed with ENGL 612. Credit cannot be given for both ENGL 612 and LING 612.

625. Applied Linguistics: English as a Second Language. (3-0). Credit 3. Relevant linguistic principles, organization, and methodology in TESOL for non-native speakers of English; development and administration of TESOL in U.S. and abroad. Prerequisites: LING 409 or equivalent and LING 602 or 662.

662. Analysis of the English Language. (3-0). Credit 3. Phonological, morphological, syntactic, and lexical components of the English language; transformational theory as well as traditional and structural grammar. Cross-listed with ENGL 662. Credit cannot be given for both ENGL 662 and LING 662.

666. Language Varieties: Regional and Social. (3-0). Credit 3. Methods and principles of linguistic dialectology; close work with published fascicles of the Linguistic Atlas of the U.S. and Canada and other data, as modified by dialectal implications from transformational theory. Prerequisites: Approval of instructor.

667. Linguistics and Literature. (3-0). Credit 3. Linguistic methods and principles applicable to understanding of literature, with a view to development of student's skills in making linguistic analyses of various kinds of literature. Prerequisites: ENGL 662 or 666; or approval of instructor.

669. Theory of Grammar. (3-0). Credit 3. Major 20th-century approaches to grammar and their implications for the description and teaching of language, especially English. Prerequisite: One graduate linguistics course or approval of instructor.

685. Problems. Credit 1 to 6. Readings to supplement the student's knowledge of English language and linguistics in areas not studied in other courses. Prerequisites: Graduate classification and approval of department head.

689. Special Topics in ... Credit 1 to 4. Selected topics in an identified area of linguistics. Prerequisites: Graduate classification and approval of department head.

DEPARTMENT OF ENTOMOLOGY

P. L. Adkisson, T. L. Archer, D. E. Bay, J. H. Benedict, H. W. Browning, D. L. Bull, H. R. Burke, J. R. Cate, Jr., R. N. Coulson, R. L. Crocker, B. M. Drees, J. V. Edelson, R. E. Frisbie, T. W. Fuchs, F. E. Gilstrap, K. F. Harris, M. K. Harris, T. K. Hayes, C. E. Hoelscher, J. A. Jackman, J. S. Johnston, L. L. Keeley, F. G. Maxwell* (Head), R. W. Meola, J. K. Olson, F. W. Plapp, D. R. Rummel, J. C. Schaffner*, M. F. Schuster, J. E. Slosser, J. W. Smith, Jr., W. L. Sterling, N. D. Stone, M. D. Summers, M. H. Sweet, P. D. Teel, G. L. Teetes, J. G. Thomas, H. W. Van Cleave, S. B. Vinson, J. K. Walker, Jr., M. O. Way, R. A. Wharton, J. B. Woolley

*Graduate Advisor

The Department of Entomology offers programs of study and research in the various specialties of entomological science including taxonomy, morphology, physiology, toxicology, ecology, behavior, biological control, pest management, forest, urban and medical-veterinary entomology. Numerous well-equipped laboratories are available for insect studies under controlled environmental conditions. Modern analytical equipment for biochemistry, physiology and insecticide research, including electrophysiology and radioisotope techniques, is available. A newly constructed insect quarantine facility and P-3 laboratory are provided for research in the various areas of biological control. The largest collection of insects in the Southwest is available to students interested in taxonomic research.

Prerequisite to major graduate work is the completion of no less than two years of approved entomological training, except that for a part of this requirement credit in certain other biological sciences may be substituted. Comprehensive courses in the biological sciences and general chemistry (and, in most cases, organic chemistry) are required of all students. In addition to the elementary undergraduate courses pertaining to various lines of major work, specific requirements are dependent upon previous training and professional experience.

(ENTO)

601. Principles of Systematic Entomology. (3-0). Credit 3. Principles, methods and history of systematic entomology; literature, newer techniques in the field and International Rules of Zoological Nomenclature. Prerequisite: Graduate classification in entomology or other biological sciences.

602. Phylogeny and Classification of Insects. (3-0). Credit 3. Phylogenetic relationships of the classes of arthropods; evolution of insects. Geological history of insects. Classification and relationships of higher insect taxa. Prerequisite: Graduate classification in entomology or other biological sciences. (Offered in 1988-89 and alternate years thereafter.)

603. Patterns in Insect Ecology. (3-0). Credit 3. Population and community ecology; emphasis on coevolutionary trends of use in avoiding problems associated with insect control; simulation and prediction of entomological events and population dynamics. Prerequisite: BIOL 357 or equivalent .

604. Immature Insects. (1-6). Credit 3. Identification of immature insects at the family level, with emphasis on terrestrial Holometabola; techniques for collecting and preserving immatures; comparisons of adult and immature classifications. Prerequisites: ENTO 301 and 302 or equivalent. (Offered in 1988-89 and alternate years thereafter.)

605. Aquatic Entomology. (3-3). Credit 4. Principles and practices concerning aquatic entomology. Biology and classification of each group of aquatic insects. Basic concepts of limnology as they apply to insects. Techniques of collecting, mounting and rearing of aquatic insects. Prerequisite: ENTO 201 or 313 or approval of instructor.

608. Principles of Biological Control. (3-0). Credit 3. Theory and practices relating to the role and use of natural enemies in arthropod and plant population regulation; review and analysis of projects in biological control; biology and behavior of entomophagous arthropods. Prerequisite: ENTO 201 or equivalent or approval of instructor.

609. Insect Microbiology. (3-0). Credit 3. Introductory course of the microbiology of insects; emphasis on structural properties of insect pathogens, mechanisms of pathogenicity, unique biological relationships between microorganisms and insects, resistance and immunity, and beneficial uses for suppressing insect pest populations. Prerequisite: One course in microbiology or approval of instructor. (Offered in 1988-89 and alternate years thereafter.)

610. Host Plant Resistance. (3-0). Credit 3. Host plant resistance programs from the standpoint of the plant breeder, plant pathologist and entomologist. Team taught with each discipline represented. Roundtable discussion of assigned reading and lectures. Prerequisite: Approval of instructors. Cross-listed with AGRO 610 and PLPA 610.

615. Insect Physiology. (3-0). Credit 3. Physiological processes of insects; metabolism nutrition, neuro-endocrinology, nerve action, cell structure, respiration, circulation, excretion and flight. Functional integration and regulatory processes of total organism. Prerequisite: ENTO 306 or equivalent.

617. Acarology. (3-3). Credit 4. Systematics, morphology, physiology, and ecology of ticks and mites. Management of acarine pests of humans, animals and plants; role of parasitic species in causation and transmission of diseases. Prerequisite: ENTO 208 or equivalent. (Offered in 1989-90 and alternate years thereafter.)

618. Medical and Veterinary Entomology. (3-3). Credit 4. Taxonomy, biology and epidemiological role of insects that directly and/or indirectly affect the health and well-being of humans and animals. Prerequisite: ENTO 208 or equivalent. (Offered in 1989-90 and alternate years thereafter.)

619. Insect Toxicology. (3-3). Credit 4. Classification and properties of major types of insecticides; chemistry, metabolism and mode of action. Selectivity, use hazards, residues and resistance. Environmental problems: biological magnification, persistence and effects on nontarget organisms. Prerequisite: One course in organic chemistry, ENTO 615 or approval of instructor.

621. Biology and Systematics of Entomophagous Insects. (2-3). Credit 3. Systematics of entomophagous insects at the family level; collecting and rearing parasitoids from their hosts; emphasis on groups used in biological control. Prerequisites: ENTO 301 and 302 or approval of instructor. (Offered in 1988-89 and alternate years thereafter.)

622. Application Theory of Biological Control. (2-0). Credit 2. Theories of population growth and stabilization; role of biotic environmental resistance; tactics for implementing biological control and characterizing effective biological control agents. (Offered in 1988-89 and alternate years thereafter.)

624. Dynamics of Wild Animal Populations. (2-3). Credit 3. Principles, models and methods for analysis of population dynamics of wild animals; analysis of contemporary research emphasizing theory and its uses in evaluation and management of wild animal populations. Laboratory emphasizes mathematical, statistical and computer modeling of population phenomena. Prerequisites: MATH 230, STAT 651, upper level ecology; or approval of instructor. Cross-listed with WFSC 624.

681. Seminar. (1-0). Credit 1. Oral reports and discussions of current research and developments in entomology and related fields; designed to broaden understanding of problems in field and to stimulate research. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4 each semester. On-the-job training in the fields of pest identification, home and garden pest control, medical and veterinary pest control, and pest management of food and fiber crop pests. Prerequisite: Graduate classification in the master of agriculture program in economic entomology or plant protection.

685. Problems. Credit 1 to 4 each semester. Entomological problems not pertaining to thesis or dissertation. Prerequisites: Graduate classification with major or minor in entomology; approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of entomology. May be repeated for credit. Prerequisite: Graduate classification.

691. Research. Credit 1 or more each semester. Research problems on taxonomy, life histories, biological control, ecology and physiology of insects, and toxicology of insecticides. Prerequisite: Graduate classification.

DEPARTMENT OF FINANCE

M. J. Alderson, S. K. Cooper, D. A. Dubofsky, W. E. Etter, D. R. Fraser, J. P. Friedman, E. P. H. Furtado, J. C. Groth, R. L. Haney, Jr., S. Kannan, J. W. Kolari**, S. L. Lummer, A. Mahajan, C. A. Phillips, R. M. Richards, P. S. Rose*, G. L. Trennepohl (Head), G. C. Uselton, L. C. Wolken

*Doctoral Student Advisor
**M.S. Student Advisor

The Department of Finance offers graduate studies leading to M.S. and Ph.D. degrees and course work supporting the College of Business Administration's M.B.A. degree.

The M.B.A. degree program includes two required courses offered by the department and permits all or part of 12 elective credit hours to be taken in finance. Areas of course work include corporate finance, management of financial institutions, investment management, money and capital markets and real estate analysis. The M.S. degree program is designed to give a greater degree of specialization in finance. The Ph.D. program emphasizes financial theory and research tools and is structured to prepare students for teaching and/or research careers in finance.

Additional information, including specific departmental requirements, may be obtained by contacting the department or the Office of the Dean, College of Business Administration.

(FINC)

629. Financial Management I. (3-0). Credit 3. Introductory course in M.B.A. program. Analysis of finance function, credit and equity markets, financing and dividend decisions; mechanics of financial analysis. Classification 6 students may not enroll in this course. Prerequisites: ACCT 640; BANA 603.

630. Financial Management II. (3-0). Credit 3. Basic concepts of finance applied to solution of business problems. Financial analysis skills further developed and refined; investment and financing decisions analyzed. Classification 6 students may not enroll in this course. Prerequisites: ACCT 640; FINC 629; graduate classification in College of Business Administration.

632. Investment Management. (3-0). Credit 3. Introductory course in investments. Nature and functioning of securities markets. Various investment media and tools for analysis of these media. Analysis of debt and equity securities. Alternative trading strategies evaluated. Prerequisite: FINC 629.

634. Theory of Finance. (3-0). Credit 3. Theoretical issues and problems of finance. For doctoral or master's students who seek an in-depth understanding of theory underlying financial decision-making. Financial theory pertaining to investment, financing and dividend decisions. Prerequisite: FINC 630.

635. Financial Management for Non-Business I. (3-0). Credit 3. External and internal factors affecting financial decision-making in the firm. Fundamental concepts of accounting and managerial economics. Prerequisite: Approval of advisor.

638. Management of Financial Intermediaries. (3-0). Credit 3. Functioning of various institutions. Differences in the asset and liability structures of institutions. Problems in financial intermediary management arising from changing economic conditions. Prerequisite: FINC 629 or 635.

639. Real Estate Development Analysis. (3-0). Credit 3. Financial aspects of real estate development; project investment characteristics and merits. Prerequisites: Graduate classification; approval of instructor.

642. Analysis of Money and Capital Markets. (3-0). Credit 3. U.S. money and capital markets. Changes in the supply of and demand for money and capital as they influence the policies of financial intermediaries, fiscal and monetary authorities and nonfinancial firms. Interest rates; factors affecting their level and structure. Flow of funds in the U.S. economy. Prerequisite: FINC 629 or 635.

645. International Finance. (3-0). Credit 3. Problems confronted by financial managers of firms with international business operations. International money and capital markets. Exchange rate risks and political risks. Prerequisite: FINC 629 or 635.

647. Financial Statement Analysis. (3-0). Credit 3. Analytical approach to financial statements; application of finance and accounting principles relevant to the analysis of financial statements. Prerequisites: ACCT 640 and FINC 629.

662. Commercial Bank Management. (3-0). Credit 3. Financial management problems of commercial bank management including raising funds, investing funds and making loans; nontraditional bank activities; emphasis on actual case situations. Prerequisite: FINC 642.

665. Speculative Markets. (3-0). Credit 3. Stocks options, financial futures, option pricing, option trading strategies, pricing of financial futures, speculation and hedging in the financial futures markets. Prerequisite: FINC 632.

671. Real Estate Analysis. (3-0). Credit 3. Survey of structure of real estate markets and characteristics of real estate resources; analytical techniques of real estate market and investment analysis; valuation procedures; and real estate marketing, financing and management methods. Concepts intergrated with microcomputer-based case analyses. Prerequisite: FINC 629 or 635.

672. Real Property Finance. (3-0). Credit 3. Primary and secondary mortgage markets. Mortgage markets' institutional organization, alternative mortgage instruments, creative financing techniques, loan underwriting factors and risk hedging strategies. Prerequisite: FINC 629 or 635.

673. Real Property Valuation. (3-0). Credit 3. Procedures used to estimate the market value of real property. Market analysis and valuation techniques most appropriate for appraising income-producing properties. Demonstration appraisal report. Prerequisites: FINC 629 or 635.

675. Analysis of Real Estate Investment Decisions. (3-0). Credit 3. Analytical techniques for real estate investment decision-making which emphasize the importance of income tax considerations, the magnitude of relevant cash flows and the timing of both. Case histories used to analyze investment problems. Prerequisites: FINC 629 or 635, and ACCT 640.

685. Problems. Credit 1 to 4 each semester. Directed study of selected problems using recent developments in business research methods. Prerequisites: Graduate classification; approval of instructor.

688. Doctoral Seminar. (3-0). Credit 3. Historical development of the conceptual framework of finance theory and practices; analysis of current research and controversial issues in the field. For doctoral students only. May be repeated for credit three times. Prerequisite: M.B.A. or equivalent.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of finance. May be repeated for credit.

690. Theory of Research in Finance. (3-0). Credit 3. Design of research in the various subfields of finance and the evaluation of research results using examples from the current research literature. May be repeated for credit. Prerequisite: Graduate classification in finance.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

FLORICULTURE

(See Horticultural Sciences)

FOOD SCIENCE AND TECHNOLOGY

E. E. Burns, Z. L. Carpenter, A. B. Childers, Jr., H. R. Cross, C. W. Dill, C. R. Engler, F. A. Gardner, S. W. Gyeszly, N. D. Heidelbaugh, T. R. Irvin, J. T. Keeton, G. T. King, K. S. Kubena, O. R. Kunze, J. R. Lupton, R. K. Miller, T. D. Phillips, K. C. Rhee, K. S. Rhee, R. L. Richter, L. W. Rooney, L. H. Russell, Jr., J. W. Savell, G. C. Smith, S. B. Smith, D. A. Suter, V. E. Sweat, C. Vanderzant, R. D. Waniska

The interdepartmental curriculum in food science and technology is administered through the office of the dean of the College of Agriculture and Life Sciences. Graduate training in food science and technology is designed to provide advanced training in the basic sciences, processing technology, and engineering with emphasis on foods. Courses of study lead to the degrees of master of science, master of agriculture or doctor of philosophy.

Departments participating in granting degrees in food science and technology include Agricultural Engineering, Animal Science (meat, seafood and dairy products), Biochemistry and Biophysics, Horticultural Sciences, Poultry Science, Soil and Crop Sciences (cereals and oil seeds) and Veterinary Public Health. Programs may be developed from the offerings of various departments and colleges which serve the needs of a food scientist.

Degree programs for graduate students are prepared on an individual basis by the student's graduate committee in consultation with the student. Support areas such as microbiology, chemistry, nutrition, biochemistry, engineering, statistics and many others may be readily arranged.

A minimum of 32 semester hours and a thesis are required for the M.S. degree (thesis option); a minimum of 36 semester hours is required for the M.S. degree (non-thesis option). For the professional M.Agr. degree, a minimum of 36 semester hours and an internship are required. Six semesters of full-time graduate study (96 semester hours) beyond the B.S. degree and a dissertation are part of the minimum requirements for the Ph.D. degree.

(FSTC)

605. Chemistry of Foods. (2-3). Credit 3. Chemistry of dairy foods and meats relating to their composition and characteristic properties important to their subsequent manufacture into food products. Prerequisite: BICH 410 or 603.

606. Microbiology of Foods. (3-0). Credit 3. Nature and function of beneficial and defect-producing bacteria in foods. Food-borne illness, effects of processing, storage and distribution. Techniques for isolation and identification from foods. Cross-listed with DASC 606.

607. Physiology and Biochemistry of Muscle as a Food. (2-2). Credit 3. Biochemical, histological, anatomical and physical characteristics of muscle cells and factors associated with transformation of muscle cells into meat. Prerequisite: BICH 410 or approval of department head. Cross-listed with ANSC 607.

608. Seafood Preservation and Processing. (3-2). Credit 4. Principles and practices involved in the processing and preservation of seafood. Prerequisite: CHEM 232 and BIOL 206 or DASC 320 or approval of department head.

611. Poultry Processing and Distribution Technology. (3-2). Credit 4. Poultry and egg composition, mechanisms of poultry and egg quality preservation, effects of storage environments, time and product treatment. Evaluation of commercial methods of product assembly, processing, distribution and quality control. Evaluation of physical, microbiological, functional and chemical methods of quality determination. Cross-listed with POSC 611.

630. Cereal Grains for Human Food. (3-3). Credit 4. Fundamental concepts of dry milling, wet milling, oil extraction, baking, malting, brewing, storage, sanitation, and quality evaluation and control interrelated with physical and biochemical properties of cereals and their products. Use of instruments and techniques to evaluate cereal quality. Prerequisite: Approval of instructor. Cross-listed with AGRO 630.

631. Chemical and Physical Characteristics of Cereals. (3-0). Credit 3. Properties of cereals and cereal products as affected by growth, storage and physical, chemical and biological factors. Dough structure and rheology and enrichment of cereal products. Prerequisite: BICH 410. (Offered in 1986-87 and alternate years thereafter.)

634. Oilseed Proteins for Foods. (3-0). Credit 3. World production, composition, processing technologies, uses of products (oil, meal, protein concentrates and isolates, and texturized products) in feeds and foods; present and potential food applications of oilseed proteins. Prerequisites: CHEM 228, 317. (Offered in 1985-86 and alternate years thereafter.)

635. Oil and Fat Food Products. (3-0). Credit 3. Composition, properties and reactions; sources, handling and storage of raw materials; extraction refining and bleaching; hydrogenation, deodorization, esterification and interesterification; fractionation; uses in salad oils, shortenings, margarine, bakery products and other foods. Prerequisites: CHEM 228, 317. (Offered in 1984-85 and alternate years thereafter.)

636. Principles of Food Analysis. (3-0). Credit 3. Classical and modern analytical methods and instruments in terms of their principles, applications and limitations as applied to analyses of foods, food ingredients, food additives and other food products for chemical, physical, functional, nutritional and organoleptic characteristics. Prerequisites: CHEM 228, 317; FSTC 314 or approval of instructor. (Offered in 1986-87 and alternate years thereafter.)

644. Food Quality. (3-0). Credit 3. Physical, chemical and biological properties of foods. Fundamental attributes of flavor, color, odor and texture. Esthetic, ethnic and nutritional requirements. Role of additives. Regulatory standards and quality control regimen. Current techniques in food investigations. Cross-listed with HORT 644. Field trip required for which departmental fee may be assessed to cover costs.

647. Technology of Meat Processing and Distribution. (3-0). Credit 3. Quantitative and qualitative characteristics of meat and meat products as related to food technology processing operations; manufacturing, preservation, packaging and merchandising. Cross-listed with ANSC 647.

667. Industrial Processed Meat Operations. (2-2). Credit 3. Application of scientific principles and business practices to manufactured meat products. Interrelationships among marketing, manufacturing, product development, regulatory compliance and quality assurance in commercial processed meat operations. Prerequisite: Approval of instructor. Cross-listed with ANSC 667.

681. Seminar. (1-0). Credit 1. Oral reports and discussions of current research and developments in food technology designed to broaden understanding of problems and to stimulate research.

684. Professional Internship. Credit 1 to 4. Experience in application of formal training to a commercial operation under supervision of operations manager and designated faculty member. Student will investigate matter of mutual interest and report results in a professional paper approved by the graduate committee.

685. Problems. Credit 1 to 4 each semester. Directed study of selected problems emphasizing recent developments in research techniques.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of food science and technology. May be repeated for credit.

691. Research. Credit 1 or more each semester. Investigations leading to thesis or dissertation in various areas of food science and technology.

DEPARTMENT OF FOREST SCIENCE

R. D. Baker, R. B. Flagler, J. C. Lee (Head), W. J. Lowe, R. C. Maggio, J. G. Massey, C. R. McKinley, C. E. Meier, R. G. Merrifield, M. G. Messina, R. J. Newton*, J. O'Laughlin, E. J. Soltes, J. P. van Buijtenen

*Graduate Coordinator

The Department of Forest Science offers graduate study programs leading to the M.S. and Ph.D. degrees in forest science. These programs are designed to provide a background for career opportunities in forestry research, management and operational activities in natural resources and related fields. The M.S. and Ph.D. degrees are intended for students who desire a specialized knowledge in one of the disciplines that support forestry as well as experience in research. The Ph.D. degree requires a significant and original contribution to forest science. A non-thesis option for the M.S. degree is available to students not intending to pursue a research career. Forestry students can obtain a non-thesis M.Agr. degree in a multidisciplinary program in natural resources development. All graduate students gain experience in teaching as a required, integral part of their graduate study experience and training.

The department provides study and training opportunities in a new building that houses modern teaching and research facilities including computer resources, laboratories, greenhouses and growth chambers. Microcomputers are an integral part of the department's teaching and research efforts. Local field research areas and the extensive pine/hardwood forests of East Texas are available for research. The department maintains active cooperative industry research programs that provide additional avenues and resources for research.

Graduate study in the Department of Forest Science is pursued in specialized areas such as: biometrics, bioprocessing, ecology, economics, forest health, forest management, genetics and tree improvement, geographic information systems, molecular biology, operations research, physiology, policy, remote sensing, silviculture, soils and nutrient cycling, tissue culture, urban forestry and wood chemistry. The department encourages interdisciplinary research involving other departmental units.

Students entering graduate work from other disciplines obtain a sufficient forestry background to demonstrate a knowledge and understanding of forestry. Requirements are dependent upon the student's graduate program orientation and counsel of the major advisor and Advisory Committee. Most graduate programs in forest science, especially for the Ph.D., usually require some breadth in several disciplines. Detailed information concerning the graduate program may be obtained from the Graduate Coordinator.

(FRSC)

601. Forest Ecology. (3-0). Credit 3. Forest communities and successions, interrelationships of various life forms of forest stands. Occasional field trips. Prerequisite: Approval of instructor.

602. Advanced Silviculture. (3-0). Credit 3. Advanced silvicultural methods, techniques and problems; current research and technical literature. Prerequisite: FRSC 305 or equivalent.

606. The Research Process. (3-0). Credit 3. Nature and objectives of graduate work, the scientific method, and basic and applied research. Introduction to design of experiments and analysis of data. Principles of organization of project proposals, theses and scientific reports.

607. Chemistry and Utilization of Biomass. (3-2). Credit 4. Chemistry and processing of biomass materials; relationships between composition, component properties and current utilization. Opportunities and limitations inherent in the use of biomass materials as renewable food, chemicals and energy feedstocks for the future. Prerequisite: CHEM 228 or approval of instructor.

608. Remote Sensing for Wildland Resource Management. (3-0). Credit 3. Remote sensing for the management of renewable natural resources; use of aerial photography and satellite imagery to detect, identify and monitor forest, range and agricultural resources; utilize remotely sensed data as input to computerized information management systems. Prerequisite: Graduate classification.

614. Economic Analysis for Forest Resource Decisions. (3-0). Credit 3. Concepts of managerial economics in forestry; survey of economic analysis and management science techniques to solve forest resource allocation and valuation problems; use of microcomputer-based models to achieve landowner, investor, and social objectives for the ownership, use and management of forestlands. Prerequisite: ECON 204 or approval of instructor.

633. Forest Genetics. (3-0). Credit 3. Specialized study of genetics as applied to forest trees; forest tree improvement and forest tree breeding; genetics of conifers and hardwoods. Prerequisite: GENE 603. Cross-listed with GENE 633. (Offered in 1989-90 and in alternate years thereafter.)

634. Forest Genetics Laboratory. (0-3). Credit 1. Methods and techniques in forest genetics, forest tree breeding: crossing, grafting, air layering, field layouts, seed handling, greenhouse techniques. Prerequisite: GENE 633. Cross-listed with GENE 634.(Offered in 1989-90 and in alternate years thereafter.)

651. Geographic Information Systems. (2-3). Credit 3. Design, planning and implementation of geographic information systems; computer hardware and software evaluation; practical experience in data entry, analysis, and update of spatial and characteristic data; linkages of GIS and artificial intelligence; use of maps and remotely sensed data as data inputs. Prerequisite: RENR 444, GEOG 398 or approval of instructor.

661. Photo Interpretation. (2-2). Credit 3. Photographic processes related to interpretation; principles, methods and techniques of photo interpretation; applications in soils, engineering materials, geology, geomorphology, water resources, transportation and urban planning. Prerequisite: Approval of instructor. Cross-listed with CVEN 661.

681. Seminar. (1-0). Credit 1. For graduate students and staff members in forestry. Presentation and discussion of current scientific work in forestry and closely related subjects.

684. Professional Internship. Credit 1 to 4. Application of forestry principles in a working environment. Prerequisite: Limited to graduate students seeking a professional degree in forestry.

685. Problems. Credit 1 to 4 each semester. Designed for investigations not included in students' research for thesis or dissertation. Problems to be selected in some aspect of forest science.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of forest science. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. Research in an approved aspect of forest science for thesis or dissertation credit.

GENETICS

D. W. Altman, K. J. Aufderheide, J. F. Baker, T. O. Baidwin, C. R. Benedict, M. J. Benedik, J. W. Bickham, A. J. Bockholt, D. L. Busbee, E. W. Collisson, S. K. Davis, K. M. El-Zik, R. C. Fanguy, A. R. Ficht, T. A. Ficht, J. R. Gold (Chair), J. W. Golden, S. S. Golden, C. F. Gonzalez, I. F. Greenbaum, T. C. Hall, G. E. Hart, G. M. Ihler, K. A. Ippen-Ihler, T. R. Irvin, J. S. Johnston, R. J. Kohel, D. C. Kraemer, W. F. Krueger, H. O. Kunkel, M. L. Lamoreux, W. J. Lowe, C. W. Magill, J. M. Magill, M. D. Manson, C. R. McKinley, T. D. McKnight, F. R. Miller, J. C. Miller, Jr., J. E. Mullet, W. D. Park, D. O. Peterson, H. J. Price, P. J. Rizzo, J. O. Sanders, D. J. Schmidly, G. L. Schroeter, L. C. Skow, J. D. Smith, D. M. Stelly, D. K. Struck, M. D. Summers, B. H. Taylor, J. F. Taylor, J. W. Templeton, J. P. van Buijtenen, K. P. VanWinkle-Swift, J. R. Wild, H. D. Wilson, V. G. Wilson, J. E. Womack, R. F. Young

Genetics, the science of heredity and variation, occupies a central position in biology. Many of the recent significant research developments in the life sciences have occurred in this dynamic discipline. Multiple opportunities exist for the further development of genetic theory and for the application of genetic principles to improve animal and plant species.

Graduate study in the various areas of genetics is supervised by the interdepartmental genetics faculty, whose training, teaching and research are directly related to genetics. Supporting course work is available in such fields as biochemistry, biophysics, computer science, cytology, pathology, physiology and statistics.

Research areas which may be pursued include biochemical genetics, cytogenetics, developmental genetics, immunogenetics, molecular genetics, population genetics, quantitative genetics, somatic cell genetics, forest genetics, animal breeding and plant breeding. Commonly used experimental organisms include bacteria, viruses, and fungi, and many species of higher plants and animals.

Graduate programs in genetics leading to the master of science and the doctor of philosophy degrees may be administered in various departments throughout the University. Graduate assistantships and fellowships are available from the genetics faculty and from individual departments. The language requirement will be determined by the student's administrative department.

Listed below are the graduate courses in genetics followed by departmental listings:

(GENE)

603. Genetics. (4-0). Credit 4. Development of fundamental concepts related to the structure, function, organization, transmission and distribution of genetic material. Prerequisite: GENE 301.

607. Genetics of Differentiation. (3-0). Credit 3. Genetics of eukaryotic differentiation from a conceptual viewpoint. The underlying theme is that development is under genetic control and results from differential gene activity. Developmental processes which determine phenotypic expression, using plant and animal examples. Prerequisite: GENE 603 or approval of instructor.

608. Genetics of Microorganisms. (3-0). Credit 3. Contributions to the understanding of genetics which have come from studies of microorganisms: bacteria, viruses, fungi, protozoa and lower algae. Areas of special interest to the students enrolled. Prerequisite: GENE 301.

610. Mammalian Immunogenetics. (3-0). Credit 3. Basic immunogenetics concepts derived from mouse, rabbit, and human, and applied to domestic and other laboratory animal species; theory and techniques in immunohematology, histocompatibility genetics, genetics of immunoglobulins, genetics of immune responsiveness. Prerequisites: GENE 301 and BIOL 458.

612. Population Genetics. (3-0). Credit 3. Biological approach to genetic characteristics of populations dealing with genetic equilibrium, allelic variation, determination of genetic variation in populations, effects of mating systems, selection, mutation and ploidy on population parameters. Prerequisites: GENE 603, STAT 651.

613. Quantitative Genetics I. (3-0). Credit 3. Quantitative genetics concepts particularly dealing with partitioning of phenotypic variance into genetic and environmental components, selection response, effects of systems of mating, genetic covariance and threshold effects. Prerequisites: GENE 612; STAT 652.

620. Cytogenetics. (3-0). Credit 3. Examination and analysis of variation in chromosome structure, behavior and number; developmental and evolutionary effects of this variation. Prerequisite: GENE 603.

625. Speciation. (3-0). Credit 3. Processes of organic evolution, particularly as they operate in the differentiation of populations and the origin of species. Prerequisite: GENE 603.

631. Biochemical Genetics. (3-0). Credit 3. Genetic control of cellular metabolism. Mechanism of gene action. Gene-enzyme relationships; regulation of gene expression; structure and organization of genomes; biochemical manipulation and characterization of genetic molecules. Prerequisites: BICH 604 or GENE 431. Cross-listed with BICH 631.

633. Forest Genetics. (3-0). Credit 3. Specialized study of genetics as applied to forest trees; forest tree improvement and forest tree breeding; genetics of conifers and hardwoods. Prerequisite: GENE 603. Cross-listed with FRSC 633. (Offered in 1985-86 and in alternate years thereafter.)

634. Forest Genetics Laboratory. (0-3). Credit 1. Methods and techniques in forest genetics, forest tree breeding; crossing, grafting, air layering, field layouts, seed handling, greenhouse techniques. Prerequisite: GENE 633. Cross-listed with FRSC 634. (Offered in 1985-86 and in alternate years thereafter.)

640. Physiological Plant Genetics. (3-0). Credit 3. Genetics of metabolic and developmental processes which control phenotypic differences; environmental and hormonal regulation of differentiation and gene expression; biogenesis and functions of mitochondria and chloroplasts; somatic cell genetics in higher plants. Prerequisite: GENE 301 or 603.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current importance in genetics. Reports to be prepared and presented by graduate students enrolled in course.

685. Problems. Credit 1 to 4 each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of genetics. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research in Genetics. (2-0). Credit 2. Design and development of research theory and methodology in various subfields of genetics, including evaluation of research data and interpretation utilizing examples of current scientific literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Prerequisite: GENE 603.

ANIMAL SCIENCE
(ANSC)

616. Quantitative Genetics II. (3-0). Credit 3.

628. Animal Breeding. (2-2). Credit 3.

BIOCHEMISTRY
(BICH)

631. Biochemical Genetics. (3-0). Credit 3.

BIOLOGY
(BIOL)

611. Molecular Biology of Differentiation and Development. (3-0). Credit 3.

616. Biochemical Systematics and Evolution. (3-3). Credit 4.

674. Cellular and Molecular Aspects of Development. (3-0). Credit 3.

FOREST SCIENCE
(FRSC)

633. Forest Genetics. (3-0). Credit 3.

634. Forest Genetics Laboratory. (0-3). Credit 1.

POULTRY SCIENCE
(POSC)

613. Concepts of Breeding Systems. (3-0). Credit 3.

RANGE SCIENCE
(RASC)

610. Range Grasses and Grasslands. (2-3). Credit 3.

SOIL AND CROP SCIENCES
(Agronomy, AGRO)

603. Cytological and Histological Principles in Plant Breeding. (2-3). Credit 3.

641. Plant Breeding I. (3-0). Credit 3.

642. Plant Breeding II. (3-0). Credit 3.

WILDLIFE AND FISHERIES SCIENCES
(WFSC)

602. Vertebrate Cytosystematics. (1-6). Credit 3.

DEPARTMENT OF GEOGRAPHY

D. D. Arreola*, G. F. Bass, R. S. Bednarz, B. W. Blouet (Head), J. R. Giardino, E. R. Hoskins, P. J. Hugill, C. Kimber, J. B. Kracht, J. M. McCloy, C. L. Smith, J. Sonnenfeld, F. H. van Doorninck, Jr., M. R. Waters, K. L. White

*Graduate Advisor

Graduate work in geography is offered at the master's and doctoral levels. The department has wide interests in human-environment relationships. Staff interests include cultural, historical, behavioral, resource, plant geographical, geomorphic, urban and economic studies.

Graduate students are required to be involved with research work and teaching. Primary data collection is encouraged. Many graduate courses are taught as seminars requiring research papers. A non-thesis option is available for master's level students.

(GEOG)

601. Professional Seminar. (3-0). Credit 3. Statements on the nature of geography; history of American geography; defining interests in geographic research; reviewing; content analysis of geographic publications; identification of special concerns in geography at Texas A&M University.

603. Processes in Economic Geography. (3-0). Credit 3. Spatial organization and distribution of economic activity; patterns of land rent and land use; theories of economic development; models of spatial decision making. Prerequisites: GEOG 204 or equivalent or approval of instructor.

604. Processes in Physical Geography. (3-0). Credit 3. Methodologies and problems of physical geography with emphasis on the interrelationships of the physical environment. A foundation course for graduate work in geography. Prerequisite: Approval of instructor.

605. Processes in Cultural Geography. (3-0). Credit 3. Evolution of cultural landscapes. Processes of innovation, diffusion and adaptation in context of developing human-environment relationships. Prerequisite: Approval of instructor.

606. Agricultural Origins and Dispersals. (3-0). Credit 3. Origin and spread of agriculture over the world; plant and animal domestications. Single versus multiple origins; single crop or livestock systems and multiple systems. The several complexes: Near East, Far East, Africa, America. A research seminar. Prerequisite: Approval of instructor.

612. Preclassical Seafaring. (3-0). Credit 3. Seafarers and watercraft of the ancient Near East and Mediterranean until ca. 700 B.C. Types of watercraft used, routes, cargoes, voyages of exploration and economics of maritime trade. Cross-listed with ANTH 612.

613. Classical Seafaring. (3-0). Credit 3. Culture history of Mediterranean seafarers between ca. 700 B.C. and end of Byzantine Empire. Types of ships and boats, sea law, naval tactics, harbor-works, routes, cargoes and economics of trade. Cross-listed with ANTH 613.

615. History of Wooden Ships. (3-0). Credit 3. Design and construction of preserved and excavated sailing ships, the expertise of their builders and technology involved in ancient and early shipbuilding. Prerequisite: ANTH 612. Cross-listed with ANTH 615.

619. Man's Impact on the Environment. (3-0). Credit 3. Human alterations of landscapes, the atmosphere and the waters of the earth; interference with natural chemical cycles; disturbance of ecological equilibria; depletion of natural resources. Roles of technology and population growth. Prerequisite: Approval of instructor.

620. Resource and Environmental Decisions. (3-0). Credit 3. Evolving views of man and nature; conflicts of ecoethics and economics, of local and national interests, of the present and posterity; coping with environmental degradation, natural hazard and resource depletion; the alternative-consequences approach to decisions. Prerequisite: Approval of department head.

624. Plant Geography. (3-0). Credit 3. Differences and similarities among the various floras and vegetations of the world. Composition, local productivity, distributions and plant migrations of taxa at different levels. Studies of man's impact may be included. Research seminar system used; particular emphasis of the course varies from year to year. Field trip. Departmental fees may be assessed to cover costs. Prerequisite: Approval of instructor.

630. Behavioral Geography. (2-2). Credit 3. Sources of variability in individual and group relationships with the environment: biocultural factors, perception, personality and the non-human environment. Review of concepts, application of research techniques and development of individual research projects, generally centering on a class theme which will vary from semester to semester. Prerequisite: Approval of instructor.

640. Historical Geography. (3-0). Credit 3. Themes of historical geography: demography, economic structure and social structure; patterns of selective migration from specified source regions to specific destinations and resulting processes and forms of settlement.

650. Cultural Geography of Middle America. (3-0). Credit 3. Investigation of the patterns of distribution of the peoples of Middle America, Mexico, the Caribbean and Central America by cultural origin, technological level and changing political affiliation. Research seminar. Focus will vary according to semester and instructor. Students are expected to defray a portion of the expenses of the field trip. Prerequisite: Approval of instructor.

670. Field Geography. (1-6). Credit 3. Advanced field geography. Review of basic field techniques. Various forms of field collection of data to complement library material; field mapping of human and physical phenomena; analysis of data gathered in the field. Students must participate in an extended field trip and are expected to demonstrate their abilities to identify and resolve a problem which can only be solved by the examination of field data. Departmental fees may be assessed to cover costs.

681. Seminar. (1-0). Credit 1. Reports and discussions of current research and selected topics. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 6 each semester. For students with major or minor in geography to undertake investigations in special aspects of geography. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of geography. May be repeated for credit.

690. Theory of Research. (3-0). Credit 3. General concepts of scientific research; specific analytical techniques in the subfields of geography.

691. Research. Credit 1 or more each semester. Original research in various areas of geography. Research for thesis or dissertation.

DEPARTMENT OF GEOLOGY

W. M. Ahr, D. M. Anderson, R. R. Berg, P. A. Domenico, S. L. Dorobek, E. L. Estes III, R. C. Fletcher, M. Friedman, L. E. Garrison, J. R. Giardino, M. C. Gilbert, E. L. Grossman, A. Hajash, Jr.*, E. R. Hoskins, B. Johnson, K. J. Koenig, W. Lamb, J. M. Logan, C. C. Mathewson, J. M. Mazzullo, T. J. Parker, R. K. Popp, A. L. Raymond, M. C. Schroeder, J. H. Spang (Head), R. J. Stanton, Jr., T. T. Tieh, N. R. Tilford, K. L. White, D. V. Wiltschko, T. E. Yancey

*Graduate Advisor

Graduate work in geology is offered at both the master's and doctoral levels. Programs are designed to provide the student with an understanding of the fundamentals of geology and of related disciplines. Research investigations comprise a significant part of each program.

Opportunities for research at both the M.S. and Ph.D. levels are available in ground-water investigations, sedimentation, clay mineralogy, paleontology and paleoecology, stratigraphy, structural geology, tectonophysics, petrology, field geology, engineering geology and geochemistry.

The Center for Tectonophysics provides unique opportunities for research in the following areas: design and analysis of physical and numerical models of structural processes; deformation of rock specimens under conditions which simulate the physical and chemical environment at depth in the earth's crust; study of deformation mechanisms in experimentally and naturally deformed rocks; interpretation of geologic structures in terms of the results of laboratory studies.

The Center for Sedimentology serves as a focus for graduate-level teaching and research in areas such as origins of sedimentary rocks, factors controlling the origin and distribution of petroleum and mineral deposits in sediments, and techniques for determining the depositional environment of ancient sediments from their lithologic and paleontologic attributes. Graduate students participating in the Center will arrange their program through the appropriate academic department as determined by their background and interests.

The Center for Engineering Geosciences and Mineral Resources Program provide the graduate student with interdisciplinary research opportunities and reflect the close research associations that exist between the Department of Geology and the Departments of Civil Engineering, Geophysics, Petroleum Engineering, Urban and Regional Planning, and Soil and Crop Sciences. Graduate students participating in these areas of interest follow the basic geology requirements but develop research interests in a variety of fields such as coastal engineering, land planning, geothermal energy, river processes, landslide mechanics and slope stability, rock mechanics, ground water resources, coal mining and reclamation, and expansive soils.

Studies in all aspects of paleoecology can be carried out within an interdisciplinary program that includes faculty in geology, oceanography, geography and anthropology. Paleoecologic studies provide opportunity for course work and research on projects involving deposits of all ages, with a primary focus in the geology department on paleobotany and marine paleoecology. Research opportunities are available in understanding the processes controlling the formation of fossil assemblages, documentation of relationships between organisms and environment, and developing tools for the study of paleoenvironments.

Although degree level is not a requirement for professional practice in geology, the B.S. should usually be considered as preparatory, the M.S. should be considered the professional degree, and the Ph.D. should be considered the teaching and research degree. The M.S. degree is granted thesis option only.

In addition to graduate studies requirements for the Ph.D., the student's committee chair, with advice from the other committee members, will determine, on an individual basis, the student's needs in either foreign language or other broadening areas of study. The graduate faculty will also require an early evaluation of all Ph.D. candidates regarding the student's potential as a research scientist.

(GEOL)

600. Earth Science for Secondary School Teachers. (2-3). Credit 3. Survey of fundamental principles of physical geology, geologic processes, the Earth's oceans, climate and weather, and Earth history; origin and nature of solar system. Designed to aid secondary school instructors in presenting earth sciences. Prerequisites: Graduate classification; approval of department head.

603. Rocks and Minerals. (2-3). Credit 3. Rocks and minerals and megascopic determination by means of their physical properties. Origins of minerals, rocks and mineral deposits. For secondary school teachers. Prerequisites: GEOL 600; graduate classification; approval of department head.

609. Field Geology. Credit 1 to 6. Individual instruction in advanced and specialized field methods, geologic interpretation and field evaluation procedures. Choice of topics and locations of field studies will vary depending upon individual and specific needs. Prerequisite: GEOL 300 or approval of instructor.

612. Structural Geology. (3-0). Credit 3. Mechanical principles important to structural geology and experimental results relating to rock deformation followed by applications to natural deformation. Mechanisms, rather than geometries. Primarily for students not concentrating in structural geology but who desire an advanced general course. Prerequisite: Approval of instructor.

618. Sedimentology. (3-0). Credit 3. Mechanisms of transportation and deposition of ancient eolian, fluvial and marine sediments. Dispersal and depositional patterns. Physical bases for sequences of textures, structures and grain fabrics in sedimentary rocks. Prerequisites: GEOL 306; MATH 152 or approval of instructor.

619. Petroleum Geology. (3-0). Credit 3. Properties of reservoir rocks; origin, migration and accumulation of petroleum; geologic interpretation of borehole logs and fluid-pressure measurements and the role of hydrostatic and hydrodynamic pressures in oil accumulation. Prerequisite: GEOL 404 or approval of instructor.

620. Geology of Ground Water. (3-0). Credit 3. Principles of occurrence and movement of water beneath Earth's surface and influence of various geologic situations upon its behavior. Factors applying to estimates of supply. Engineering aspects of ground water. Prerequisite: Approval of instructor.

622. Stratigraphy. (3-0). Credit 3. Principles of correlating and naming stratigraphic units; interpretation of sedimentary environments based on composition, texture and sedimentary structures; prediction of sandstone-body morphology of cored sections. Prerequisite: Graduate classification or approval of instructor.

623. Carbonate Rocks. (3-0). Credit 3. Fundamental properties of carbonate rocks; depositional and diagenetic microfacies; interpretation of depositional models in carbonates. Practical work on core samples representing a suite of ancient depositional and diagenetic environments. Emphasis on improving skills in energy and mineral exploration in carbonate terranes. Prerequisites: Graduate classification; GEOL 303, 306 or approval of instructor.

629. Regional Geology of North America. (3-0). Credit 3. Regional geology of North America, examining the accumulation and deformation of the rock units involved. Structural form and style are emphasized, but the entire geologic history is investigated. Prerequisite: Graduate classification or approval of instructor.

631. Engineering Geomorphology. (3-0). Credit 3. Active surface processes as they influence engineering construction; erosion, rivers and floods, slope processes, subsidence, coastal processes, ice, weathering and groundwater. Prerequisites: Graduate classification in engineering or geosciences; GEOG 431 or approval of instructor.

632. Site Investigation. (2-3). Credit 3. Photogrammetry, photogeology, remote sensing, engineering geophysics and field methods applied to site investigations. Identification of geologic characteristics significant to engineering construction. Prerequisite: Graduate classification in engineering or geosciences.

635. Engineering Geology. (3-0). Credit 3. Geological principles applied to the investigation design, construction and maintenance of engineering projects; history, development and role of engineering geologic practice as applied to dams, waste disposal, surface and ground water, tunneling, quarrying and construction materials.

636. Siting Critical Facilities. (3-0). Credit 3. Synthesis of geologic, engineering, public welfare and economic factors as they apply to the siting of critical facilities (nuclear plants, LNG/LPG terminals, major dams, hazardous and nuclear waste disposal) to provide an integrated analysis of the role of engineering geology in the siting of these facilties. Prerequisite: Graduate classification in geology or civil engineering.

637. Fundamental Geology. (3-0). Credit 3. Fundamental geologic principles taught at a graduate level. For students with little or no undergraduate background in geology who are pursuing studies that cross traditional disciplinary boundaries. Mineralogy, petrology, geomorphology and structural geology. Prerequisite: Approval of department head.

640. Aqueous and Sedimentary Geochemistry. (3-0). Credit 3. Basic solution geochemistry and equilibria concepts related to formation and alteration of sedimentary materials of low temperature origin. Geochemistry of fluids in natural aqueous environments; diagenesis and weathering. Prerequisite: Approval of instructor.

648. Stable Isotope Geology. (2-3). Credit 3. Stable isotopes of oxygen, carbon, sulfur and hydrogen applied to problems in paleontology and paleoecology, carbonate diagenesis, petroleum exploration, and igneous and metamorphic petrology; isotopic paleotemperatures; analytical methods; theory of isotopic fractionation. Prerequisite: GEOL 451 or approval of instructor.

650. Paleoecology. (2-3). Credit 3. Interrelationships of organisms and environment in the fossil record. Methods and criteria available for interpreting ancient environments. Critical review of classic studies and current research in paleoecology. Prerequisite: Approval of instructor.

652. Biogeology. (2-3). Credit 3. Major trends and processes in the evolution of life through geologic time. Interrelationships of biological and physical processes in earth history. Application of paleontology to current problems in geology. Critical review of modern developments in biogeology. Prerequisite: GEOL 305 or approval of instructor.

659. Volcanic Geology. (3-0). Credit 3. Thermochemical volcanic phenomena of the dynamic Earth; heat flow; melting and eruptive mechanisms; chemical petrology of volcanic rocks; significance of volcanism to climate, energy sources, economic deposits, paleomagnetism, geochronology and archaeology; volcano control and prediction; extraterrestrial volcanism. Prerequisite: Approval of instructor. Offered in 1989-90 and alternate years thereafter.

660. Theoretical Petrology. (2-3). Credit 3. Thermodynamics for geologists with petrologic applications; derivation and use of thermodynamic equations; relationships between measured quantities and thermodynamic generalizations; concept of chemical potential; phase rule and phase relations in silicate systems. Other potential topics include influence of volatiles upon silicate systems, and kinetics of nucleation and crystal growth. Prerequisite: Approval of instructor.

661. Igneous and Metamorphic Rock Systems. (2-3). Credit 3. Origin and evolution of igneous and metamorphic rocks. Laboratory research problems concentrate upon the petrogenesis of genetically related suites of igneous and metamorphic rocks. Prerequisite: Approval of instructor.

662. Sedimentary Petrology. (2-6). Credit 4. Genesis and diagenesis of limestones and shales. Studies of primary rock properties to enable synthesis of depositional models. Laboratory work includes staining methods and preparation and study of thin sections and polished slabs. Prerequisite: GEOL 303 and 304 or approval of instructor.

663. Mineralogy. (2-6). Credit 4. Structure, chemistry, physical properties and geological occurrence of minerals. Important rock-forming and ore minerals. Prerequisite: Approval of instructor.

664. Mechanical Analysis in Geology. (3-0). Credit 3. Mechanical analysis of geological problems based on concepts of stress, strain, strength, elasticity, viscosity and plasticity. Folding, faulting, dike formation, hydraulic fracturing, magma and glacial flow, and cooling of magmatic bodies. Prerequisites: MATH 253; approval of instructor.

665. Structural Petrology. (2-3). Credit 3. Mechanisms of rock deformation from single crystal to mountain range. Techniques for mapping stresses and strains and for inferring physical conditions and mechanical behavior at time of deformation. Laboratory assignments on descriptive techniques include petrographic microscope-universal stage methods, field procedures and data analysis. Prerequisites: GEOL 303, 312; approval of instructor.

666. Principles of Geodynamics. (4-0). Credit 4. Geological and geophysical methods and phenomena pertinent to geodynamics. Plate tectonics; seismicity and seismology; magnetics; gravity; heat flow; igneous, metamorphic and sedimentary petrology; paleontology; and rock mechanics. Prerequisite: Approval of instructor. Cross-listed with GEOP 666 and OCNG 666.

667. Structural Geology II. (3-0). Credit 3. Application of theoretical and experimental results to problems in natural rock deformation. Structural mechanisms on the phenomenological, laboratory and natural scales with emphasis on the genesis of structural features in layered rocks. Prerequisites: GEOL 665, GEOP 611, 615.

672. Sandstone Petrology. (2-3). Credit 3. Measurement and analysis of the size, shape and compositional characteristics of sediments and sedimentary rocks; the concept of sediment provenance; sandstone diagenesis, the petrography of diagenesis and the evolution of secondary porosity in a sandstone; scientific methods of sampling, data representation and analysis. Prerequisites: GEOL 304 and 306 or equivalents.

681. Seminar. (1-0). Credit 1. Reports and discussions of current research and selected topics from geologic literature. Students may register in up to but no more than two different sections of this course. Prerequisite: Graduate classification.

685. Problems. Credit 1 or more each semester. A course to enable graduate students with major or minor in geology to undertake limited investigations not within their thesis or dissertation research and not covered in established curricula. Prerequisites: Graduate classification; approval of department head.

689. Special Topics in . . . Credit 1 to 4. Lectures and readings in special topics not otherwise covered in other courses. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Original research on problems in various phases of geology. Research for thesis or dissertation.

DEPARTMENT OF GEOPHYSICS

R. L. Carlson, N. L. Carter, D. A. Fahlquist, R. C. Fletcher, A. F. Gangi, T. W. C. Hilde, E. R. Hoskins, B. Johnson, A. K. Kronenberg, J. M. Logan, R. J. McCabe, F. D. Morgan, P. D. Rabinowitz, J. E. Russell, W. W. Sager, T. W. Spencer, R. R. Unterberger, J. S. Watkins (Head)

The degrees of master of science and doctor of philosophy are offered in geophysics. Geophysics includes all areas of scientific inquiry which deal with the physical state of the planets and with the dynamic physical processes which act on and within the planets. The deep interior, crust, atmosphere, oceans and space all lie within the province of the geophysicist. To work effectively in so broad an area requires considerable depth and breadth of understanding of physical principles and considerable proficiency in mathematics. Thorough undergraduate training in an earth or physical science is ordinarily regarded as a necessary prerequisite for advanced study.

Current research areas of members of the department include studies in theoretical and model seismology bearing on the internal structure of the Earth, earthquake mechanisms and seismic exploration; studies in experimental rock deformation bearing on the failure strength of rocks, friction in rocks, the rheological properties of rocks and earthquake prediction; studies of the anisotropy and anelastic properties of sedimentary rocks and application to exploration, and regional and global seismology; marine studies of the structure of the oceanic crust and continental margins in the Gulf of Mexico, the Caribbean Sea and the Western Pacific; studies of magnetic

anomalies near mid-ocean-ridge systems and the magnetization of oceanic crust; the analysis of magnetic and gravity anomalies and application to exploration and global geophysics; gravity anomalies near trenches, convection in the mantle and global tectonics; thermal interaction of the core and mantle; the physical nature of the core; mineral physics at high pressure and temperature; vertical seismic profiling; attenuation of seismic waves; radar and sonar probing in salt and potash to predict rock conditions in advance of mining; mining engineering and geophysics; and mineral resource development.

The department operates an extensive computer facility based on a VAX 11/780 computer. Software and peripherals allow a wide variety of applications including the processing of seismic reflection data, finite element calculations, large geophysical data-base management and inverse theory calculations. Interactive terminals are available throughout the department. The research vessel *Gyre* is available for research in the marine environment. Special department facilities include a seismic field station equipped with telemetered output; a two-dimensional seismic modeling laboratory for study of elastic-wave propagation in earth structures and the radiation fields generated by brittle fracture; exploration-type digital seismic recording systems; a 30-kilowatt peak-power, low-frequency radar for long-range underground electro-magnetic-wave propagation and two smaller radars operating at different frequencies for short-range probing; a LaCoste-Romberg gravity meter; and two matched optically-pumped Rb^{87} vapor magnetometers for high-sensitivity (.01γ) recording; 12 sets of instruments for measuring triaxial deformation.

(GEOP)

604. Marine Geophysics. (3-3). Credit 4. Geophysical exploration methods. Analysis and interpretation of seismic reflection and refraction profiles and gravity, magnetic and heat-flow anomalies. Structure of oceanic and continental crust as deduced from geophysical measurements. Analysis and interpretation of data from both marine and continental areas. Prerequisites: MATH 122; PHYS 218, 219; or approval of instructor.

607. Rheology and Plate Dynamics. (3-0). Credit 3. Fundamental understanding of the rheology of rocks, as a function of physical conditions, with applications to the driving forces for plate motions and the generation of first-order lithospheric structures mainly at plate boundaries. Prerequisites: GEOP 611, 615; GEOL 665 or approval of instructor.

608. Nature and Mechanics of Oceanic Lithosphere. (3-0). Credit 3. The mechanics of the oceanic lithosphere as deduced from its physical nature and properties and from seafloor processes, structure and bathymetry. Prerequisites: GEOP 607, 611, 666 or approval of instructor.

609. Physical Properties of the Continental Lithosphere. (3-0). Credit 3. Current understanding of depth- and time-dependent mechanical behavior and governing deformational processes of continental lithospheric rocks typical of cratonic and orogenic regions; laboratory-determined fracture and flow relations and processes emphasized and compared with information based on geological and geophysical observations, inferences and theory. Prerequisite: GEOP 607 or approval of instructor.

610. Plasticity and Creep in the Earth's Interior. (3-0). Credit 3. Evaluation of the roles of mineral plasticity, solid-state and viscous flow in the geophysical processes, including plate kinematics, intra-plate deformation, convection of the mantle, and dynamics of the core; discussion of characterizations of composition, state, and relevant physical and chemical conditions affecting mechanical response. Prerequisite: Approval of instructor.

611. Geomechanics. (3-0). Credit 3. Development of continuum mechanics and its application to rock deformation. Stress, strain, stress equilibrium, constitutive relations. Governing equations for elastic solids and viscous fluids formulated and used to solve elementary boundary-value problems which have application to structural geology and solid-state geophysics. Prerequisite: MATH 221 or equivalent.

614. Continuum Mechanics of Geologic Materials. (3-0). Credit 3. Continuation of GEOP 611. Power-law fluid, plastic solid and anisotropic materials. Analysis of plane-strain and plane-stress in elasticity and viscous flow problems using complex variable theory; slip-line treatment of plane flow of a rigid-plastic solid. Prerequisites: GEOP 611; MATH 308.

615. Experimental Rock Deformation. (2-3). Credit 3. Results of laboratory testing of mechanical properties of rocks at high pressure and temperature; interaction of theoretical, experimental, petrofabric and field studies of rock deformations as applied to problems in structural geology, seismology and engineering. Philosophy of experimentation, apparatus design, data interpretation and extrapolation. Prerequisite: GEOP 611 or GEOL 665 or approval of instructor.

616. Mechanics of Large Scale Tectonic Structures. (3-0). Credit 3. Formulation of models of major tectonic structures such as folds, faults, and salt domes; methods of mechanical analysis; features of the natural structures and the physical basis of their formulation. Prerequisite: GEOP 611 or equivalent.

640. Field Methods in Rock Mechanics. (2-0). Credit 2. Field instrumentation for measuring *in situ* stress, strain and displacement in rock mechanics investigation; instrument design and construction, limitations, assumptions, applications and data interpretation. Prerequisite: GEOL 312 or equivalent or approval of instructor.

650. Seismic Data Analysis. (3-0). Credit 3. Processing, modeling, migration and inversion of seismic data. Prerequisites: GEOP 436 and 450.

651. Theoretical Seismology. (3-0). Credit 3. Wave propagation in unbounded and bounded elastic media. Seismic reciprocity and the elastodynamic representation theorem. Radiation patterns from earthquake sources. Body waves, Rayleigh waves, Stoneley waves, Love waves and Lamb waves. Characteristic equation for surface waves in a layered halfspace. Dispersion and phase and group velocities. Methods of stationary phase and steepest descents; Cagnaird-deHoop technique. Ray theory in an inhomogeneous earth. Inversion of travel times. Viscoelastic wave propagation. Normal modes of vibration of the earth. Prerequisites: GEOP 436, 611 or approval of the instructor. (Offered spring 1986 and alternate years thereafter).

652. Earthquake Seismology. (3-0). Credit 3. Seismometry and earthquake precursors; mathematical theory of elasticity and its application to earthquake studies; dissipation of discrimination between underground nuclear explosions and earthquakes.

653. Analysis of Gravity and Magnetic Fields. (3-0). Credit 3. An advanced lecture-seminar course in the application of potential theory to the analysis of the Earth's gravity and magnetic fields and to the solution of geologic problems. Critical study and evaluation of techniques for the interpretation of gravity and magnetic data. Prerequisite: GEOP 475 or approval of instructor.

657. Planetary Interiors. (3-0). Credit 3. Structure, composition and physical state of planetary interiors with primary emphasis on the Earth. Constraints on models of the Earth's interior imposed by seismic, gravity, heat-flow and electrical conductivity data. Thermodynamics of the Earth. Geomagnetism. Earth motion, rotation and deformation; the Earth tides. Prerequisites: GEOP 446, 611 or approval of the instructor.

666. Principles of Geodynamics. (4-0). Credit 4. Geological and geophysical methods and phenomena pertinent to geodynamics. Plate tectonics; seismicity and seismology; magnetics; gravity; heat flow; igneous, metamorphic and sedimentary petrology; paleontology; and rock mechanics. Prerequisite: Approval of instructor. Cross-listed with GEOL 666 and OCNG 666.

681. Seminar. (1-0). Credit 1. Discussion of subjects of current importance. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 6 each semester. For graduate students with a major or minor in geophysics to undertake limited investigations not within their thesis or dissertation research and not covered in established curricula. Prerequisites: Graduate classification and approval of department head.

689. Special Topics in . . . Credit 1 to 4. Prerequisites: Graduate classification and approval of instructor.

690. Theory of Geophysical Research. (2-0). Credit 2. Theory and design of research problems and experiments in various subfields of geophysics. Communication of research proposals and results. Evaluation of current research of faculty and students and of that in the scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research toward thesis or dissertation.

DEPARTMENT OF HEALTH AND PHYSICAL EDUCATION

W. S. Barnes, B. S. Beall, C. J. Bunting, J. M. Chevrette, J. R. Coast, S. F. Crouse, L. J. Dowell*, J. R. Elledge, C. P. Gabbard, R. S. Hurley, M. J. Little, R. H. Pender, L. D. Ponder* (Head), B. E. Pruitt, N. G. Schmidt, C. H. Shea, H. Tolson, W. E. Wylie

*Graduate Advisor

Graduate study in health education and physical education is offered leading to the master of education, master of science (thesis or non-thesis), doctor of education and doctor of philosophy degrees. A foreign language is not required for the doctoral degree.

Graduate courses in health education are designed to assist in the advanced preparation of master teachers, researchers and administrators in school health education or community health education. Graduate courses in kinesiology are designed to assist in the advanced preparation of coaches, teachers and administrators at the elementary and secondary school levels, and master teachers, researchers and administrators at the college level. A professional teaching certificate in health education and in kinesiology may be earned in the department.

Graduate degrees in allied health education are offered in conjunction with Baylor College of Medicine. They are designed to prepare instructional and/or administrative personnel for allied health teaching programs in either community colleges, hospitals or four-year colleges of allied health professions. This program is open only to individuals with a baccalaureate degree, appropriate certification and experience in an allied health field.

The department maintains laboratories in exercise physiology, motor learning, child development and kinemechanics. These laboratories are for class use and research activities.

A specialization in cardiac rehabilitation is offered in conjunction with Baylor College of Medicine. This program culminates in a nine-month internship in the Cardiac Rehabilitation Program at Methodist Hospital in Houston. Study in this area prepares graduates for the American College of Sports Medicine certification program in cardiac rehabilitation.

Health education master's degree students seeking preparation for training and development positions in the corporate sector or in governmental agencies may elect to include that specialization within their degree programs. The specialization includes courses in the development, operation, management, and evaluation of training and development programs, strategic planning, communications, marketing and organizational behavior; and a training and development internship appropriate to the major field of study.

Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling, or administering in junior and community colleges, technical colleges, or universities. Within the framework of a number of doctoral programs at Texas A&M University, it is possible to pursue a concentration in higher education as a cognate area. Courses available include: EDAD 610, 626, 655; EDCI 601, 606; EPSY 669, 670; INED 604; ADEX 645 and SAED 624.

HEALTH
(HLTH)

601. Readings in Health and Kinesiology. (3-0). Credit 3. Study of published reports and research in fields of health and kinesiology. Cross-listed with KINE 601.

610. Health Assessment. (3-0). Credit 3. Concepts and procedures of health assessment, interpretation of health appraisal instruments; function of health assessment in health education, health promotion and wellness programs. Prerequisites: HLTH 425 or course in Statistics.

620. Understanding Human Sexuality. (3-0). Credit 3. Instruction in and development of an understanding of the physical, mental, social, emotional and psychological phases of human relations as they are affected by male and female relations; understanding humans' sexuality as a health entity.

621. Principles of Health. (3-0). Credit 3. Consideration is given to health concerns, foundations to personal health and health concepts and principles.

622. Issues and Trends in Health Education. (3-0). Credit 3. Background and development of health education as an applied science; current issues and trends in health education and their implications for health education.

624. Drugs and Human Health. (3-0). Credit 3. Beneficial and harmful uses and effects of drugs. Motivations behind drug abuse, especially among youth, and implications of this problem on the individual and society. Legislative and educational efforts in this area.

631. Community and Public Health. (3-0). Credit 3. Community health problems; public health laws; national, state and local health agencies.

635. Technological Applications in Health Education. (3-0). Credit 3. Utilization of technologies in preparing health information for teaching; appraising and analyzing health related data; and managing health information data bases. Prerequisite: Computer literacy.

636. Advanced Tests and Measurements. (3-0). Credit 3. Tests and measurements; methods of constructing and evaluating tests. Prerequisite: HLTH 425 or equivalent.

640. Health Intervention and Wellness. (3-0). Credit 3. Wellness as a concept and a process; systematic planning, implementation and evaluation of wellness programs and review of research relating to the efficacy of wellness programs and methods.

650. Allied Health Education. (3-0). Credit 3. Tasks associated with the development, implementation and evaluation of educational programs and program materials for the allied health professions. Pedagogical concepts and procedures. Clinical instruction techniques. Prerequisite: Training and certification as a practitioner in an allied health profession.

651. Administration of Allied Health Education. (3-0). Credit 3. Administrative problems, issues and processes involved in programs designed to educate personnel for the allied health professions and services. Prerequisite: HLTH 650.

660. Health Issues in Aging, Dying, and Death. (3-0). Credit 3. Health issues related to aging, dying and death including: health problems of aging individuals; community response to health problems of aging individuals; issues regarding definitions of death; bereavement, grief and mourning and educational implications of aging, dying and death. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current interest in the discipline.

682. Seminar in . . . (1-0). Credit 1. Issues, developments and trends within the discipline in school and public health; specific topics designated for each seminar. Prerequisite: Approval of department head.

683. Practicum in Health Education. (1-6). Credit 3. Observations and study of the discipline in school, public and institutional health settings. May be repeated twice for credit. Prerequisite: Approval of department head.

684. Professional Internship. Credit 1 to 6 each semester. Designed to permit students the opportunity for on-the-job training with professionals in schools and public and institutional health agencies. Prerequisites: Twelve semester hours of selected graduate work and approval of department head.

685. Problems. Credit 1 to 4 each semester. Directed study of selected problems within the discipline.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of the discipline. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Research in the Discipline. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of the discipline. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of department head. Cross-listed with KINE 690.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

OUTDOOR EDUCATION (ODED)

600. Field Studies in Outdoor Education. Credit 3. A field-based learning experience designed for public school and college teachers and youth agency personnel to develop an environmental awareness; to develop teaching strategies in outdoor education activities; and to learn techniques for implementing outdoor education programs. May be repeated once for credit. Prerequisite: Approval of instructor.

606. Outdoor Experiential Education. (3-0). Credit 3. Utilizing the outdoors as an interdisciplinary educational tool; environmental and adventure techniques for experiential learning in a variety of curriculum areas.

608. Leadership in Outdoor Education. (2-2). Credit 3. School and college programs in outdoor education for teachers and recreation leaders to develop skills for leadership and organization of outdoor adventure programs.

689. Special Topics in . . . Credit 1 to 4. Study of selected topics in an identified area of outdoor education. May be repeated for credit.

KINESIOLOGY (PHYSICAL EDUCATION) (KINE)

601. Readings in Health and Kinesiology. (3-0). Credit 3. Study of published reports and research in fields of health and kinesiology. Cross-listed with HLTH 601.

606. Psychological Aspects of Sport and Physical Activity. (3-0). Credit 3. Human behavior in sport and physical activity. Exceptional performances; sport and personality; movement perception; motivation in sports; and maturation and physical activity.

610. Administration of Interschool Athletics. (3-0). Credit 3. For school superintendents, principals and athletic directors. Various problems in administration of interschool athletic programs.

614. Philosophy and Principles. (3-0). Credit 3. Major schools of philosophical thought, leaders and forces affecting past and present development of kinesiology.

622. Supervision of Health and Kinesiology. (3-0). Credit 3. Principles and processes of supervision; in-service training of personnel.

623. Administration of Health and Kinesiology. (3-0). Credit 3. Administration of comprehensive programs of health, kinesiology and intramurals.

627. Analysis of Movement. (3-0). Credit 3. Science of human motion. Relationship between structure and function in accordance with general mechanical laws and interrelated factors. Prerequisite: KINE 426 or equivalent.

630. Mechanical Analysis of Motor Activity. (3-0). Credit 3. Human movement with emphasis on sports skills by application of principles of mechanics, kinesiology and cinematographical analysis. Prerequisite: KINE 627 or approval of instructor.

633. Principles of Exercise and Physical Fitness. (3-0). Credit 3. Nature of physical fitness, basic principles of exercise and physical fitness, analysis of methods of developing and evaluating physical fitness. Prerequisites: ZOOL 219, 220 or equivalent.

636. Advanced Tests and Measurements. (3-0). Credit 3. Tests and measurements; methods of constructing and evaluating tests. Prerequisite: KINE 425 or equivalent.

637. Exercise Physiology I. (3-0). Credit 3. Functional changes brought about by acute and chronic exercise sessions; topics include muscle structure/function, energy transduction, muscle mechanics, fatigue and adaptation. Prerequisite: KINE 433.

638. Exercise Physiology II. (3-0). Credit 3. Functional changes brought about by acute/or chronic exercise sessions; topics include biochemistry of exercise, cellular and general metabolism, pulmonary and cardiovascular physiology, training and detraining, fatigue and special topics. Prerequisite: KINE 637.

639. Exercise Electrocardiography. (3-0). Credit 3. Electrocardiography for the exercise scientist; emphasis on recognition and interpretation of normal and aberrant ECG patterns encountered during the graded exercise test; physiologic mechanisms underlying the normal and abnormal ECG. Prerequisite: VTPP 601.

640. Motor Skill Learning and Performance. (2-2). Credit 3. Factors involved in the learning and performance of motor skills. For teachers, coaches and those concerned with human performance in motor activity. Prerequisite: KINE 406 or equivalent.

641. Motor Development. (3-0). Credit 3. Motor, physical, and neuromuscular development from prenatal periods to old age. Stages of development, motor system and development of specific movement patterns. Prerequisite: KINE 406 or equivalent.

647. Instrumentation and Techniques in Exercise Physiology I. (1-3). Credit 2. Theory, experiments and demonstrations in exercise physiology; limited laboratory experience in the use of metabolic and biochemical instrumentation commonly found in a modern exercise physiology laboratory. Prerequisite: Concurrent enrollment in KINE 637.

648. Instrumentation and Techniques in Exercise Physiology II. (1-3). Credit 2. Theory, experiments and demonstrations in exercise physiology; limited laboratory experience in the use of metabolic and biochemical instrumentation commonly found in a modern exercise physiology laboratory. A continuation of KINE 647. Prerequisite: Concurrent enrollment in KINE 638.

650. Microcomputer Utilization in Sports Statistics. (3-0). Credit 3. Microcomputer techniques for the development and maintenance of statistics in sports; determination of frequency, trends and tendencies in sports; knowledge of BASIC required. Prerequisite: KINE 425 or equivalent.

655. Recreation and Sports Law. (3-0). Credit 3. Legal principles affecting sponsors and users of recreation, parks and sports programs; liability concepts in tort, contract, civil rights and property law in program planning, development and management. Prerequisite: REPK 609 or approval of instructor. Cross-listed with REPK 655.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current interest in kinesiology.

682. Seminar in . . . (1-0). Credit 1. Issues, developments and trends in kinesiology. Specific topics will be designated for each seminar as it is offered. Prerequisite: Approval of department head.

683. Practicum in Kinesiology. (1-6). Credit 3. Observation and study of rehabilitation and kinesiology programs in schools and other institutions. May be repeated twice for credit. Prerequisite: Approval of department head.

684. Professional Internship. Credit 1 to 6 each semester. Designed to give prospective kinesiology supervisors, administrators and corrective or physical therapists on-the-job clinical training under the guidance of successful, experienced personnel. Prerequisite: Twelve semester hours of selected graduate work and approval of department head.

685. Problems. Credit 1 to 4 each semester. Directed study of selected problems in kinesiology not related to thesis.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of kinesiology. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Kinesiology Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of kinesiology. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Cross-listed with HLTH 690.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

DEPARTMENT OF HISTORY

R. J. Q. Adams*, S. Alpern, G. C. Anderson, T. H. Anderson, D. Baum, G. E. Bayliss, R. A. Beaumont, S. J. Black, C. A. Bouton, J. C. Bradford, H. W. Brands, A. S. Broussard, K. L. Bryant, Jr., W. L. Buenger*, R. A. Calvert, J. L. Canup, J. R. Chavez, J. C. Coopersmith, J. G. Dawson, D. Delia, H. C. Dethloff, C. S. L. Dunning, B. D. Gooch, R. D. Gooden, L. D. Hill (Head), W. D. Kamphoefner, P. M. Kane, D. T. Knobel, Z. J. Kosztolnyik, A. P. Krammer, J. H. Lenihan, H. C. Livesay, D. J. Pisani, R. P. Resch, H. C. Schmidt, D. E. Schob, P. Stranahan, A. N. Stranges, V. H. Treat, B. M. Unterberger, F. E. Vandiver, L. W. Yarak

*Graduate Advisor

Graduate study in history leads to the degrees of master of arts and doctor of philosophy. The graduate program is designed to prepare students for careers in teaching, business, government and social service. Studies toward the Ph.D. are also designed to produce research scholars.

Prerequisites: For a major in history at the master's level, the student must present a minimum of 24 semester hours (including 12 advanced hours) of acceptable undergraduate courses in history. A doctoral student will normally be expected to hold the M.A. degree. For further information concerning the requirements for the M.A. or Ph.D., contact the departmental graduate advisor.

The thesis option M.A. degree includes a minimum of 24 semester hours of course work plus 6 semester hours of research credit for the thesis. The non-thesis M.A. degree option includes 36 semester hours of course work. The Ph.D. requires a minimum of 48 semester hours of course work (including 12 semester hours in a minor field outside of history) and a minimum of 16 hours of research credit for the dissertation.

M.A. students must demonstrate a reading knowledge of one foreign language. Ph.D. candidates will normally demonstrate a reading knowledge of two foreign languages. Subject to the approval of the Ph.D. student's Advisory Committee, a minimum of 6 semester hours of graduate work outside the major and minor fields, completed after filing a degree plan, may be substituted for one language. Courses in statistics or History 630 (Quantitative Methods in Historical Research), plus an additional computer methods research course, are especially appropriate for this purpose.

(HIST)

601. American Colonial Life and Institutions. (3-0). Credit 3. The 17th and 18th century English American colonies. Prerequisite: Approval of department head.

604. Age of Jefferson. (3-0). Credit 3. Revolutionary movement; organization of the new government; the Federal System; Jeffersonian democracy; the War of 1812; the New Nationalism; political, social and economic problems; territorial expansion. Prerequisite: Approval of department head.

605. Jacksonian America, 1829-1861. (3-0). Credit 3. Causes and/or origins of the Civil War with special emphasis on political, economic and social issues and the rise of sectionalism. Prerequisite: Graduate classification.

610. The Trans-Mississippi West. (3-0). Credit 3. The West in American history. Political, economic, social and cultural influences of frontier. Prerequisite: Approval of department head.

612. The French Revolution and Napoleon (3-0). Credit 3. Problems relating to French Revolution, Bonaparte's career and First French Empire. Prerequisite: Approval of department head.

613. Twentieth Century United States Diplomacy. (3-0). Credit 3. United States foreign policies from end of Spanish-American War to present; scope, principles, practices, objectives, dangers and lessons learned. Prerequisite: Approval of department head.

615. Colonial Latin America. (3-0). Credit 3. Political, economic, religious, military and related institutions, both in theory and practice, as proposed, developed and applied in Spanish-American colonies and nations. Prerequisite: Approval of department head.

616. United States-Latin American Relations. (3-0). Credit 3. Formation and development of U.S. policy towards Latin America with principal emphasis upon major policies: Monroe Doctrine, interventionism, Pan-Americanism, Good Neighbor Policy and recent trends. Prerequisite: Approval of department head.

617. Latin America: The National Period. (3-0). Credit 3. Political, institutional and economic history of Latin America from 1810 to the present with special focus on military, urban and rural developments. Prerequisite: Approval of department head.

621. The United States, 1877-1914. (3-0). Credit 3. Economic, social, political history of the U.S., 1877-1914: growth of industrialism, disappearance of the frontier, labor and farm organizations, the growth of American imperialism, and constitutional development. Prerequisite: Approval of department head.

622. The United States, 1914 to 1945. (3-0). Credit 3. The U.S. during World War I, the Twenties, the Depression, the New Deal and World War II. Prerequisite: Approval of department head.

623. The United States, 1945 to the Present. (3-0). Credit 3. The Cold War, events and issues in the U.S. since 1945. Prerequisite: Approval of department head.

626. Recent American Cultural and Intellectual History. (3-0). Credit 3. Contribution of social and political thought, religion, science, scholarship and education to the history of American civilization. Prerequisite: Approval of department head.

628. Historiography. (3-0). Credit 3. Analysis of historical writing and the philosophy of history. The works of important historians from Herodotus to the present; schools, theories and the function of history. Prerequisite: Approval of department head.

629. United States Historical Bibliography. (3-0). Credit 3. Bibliographical sources and the nature and extent of materials for the study, interpretation and writing of U.S. history. Prerequisite: Approval of department head.

630. Quantitative Methods in Historical Research. (3-0). Credit 3. Introduction to formal methods of analysis in historical research using computers; and applying quantitative methods to research problems. Prerequisite: Approval of instructor.

631. Reading Seminar in United States History to 1877. (3-0). Credit 3. Prerequisite: Approval of department head.

632. Reading Seminar in United States History after 1876. (3-0). Credit 3. Prerequisite: Approval of department head.

633. Reading Seminar in the American West. (3-0). Credit 3. Prerequisite: Approval of department head.

635. Reading Seminar in American Diplomatic History. (3-0). Credit 3. Prerequisite: Approval of department head.

636. Reading Seminar in the History of the South. (3-0). Credit 3. Prerequisite: Approval of department head.

638. Seminar in Medieval Europe. (3-0). Credit 3. Institutional, social and cultural development in Medieval Europe; the era of Charlemagne to the formation of the English parliament. Prerequisite: Approval of department head.

639. Seminar in Nineteenth Century Europe. (3-0). Credit 3. Prerequisite: Approval of department head.

640. Seminar in Twentieth Century Europe. (3-0). Credit 3. Studies in the political, diplomatic and social history of Europe in the 20th century. Prerequisite: Approval of department head.

641. The Russian Revolution and Civil War. (3-0). Credit 3. This course will explore aspects of the Russian Revolution and Civil War and emphasize the evolution of Bolshevik ideology, its relevance to revolutionary Russia; and the consequences of Leninism in the formation of the Soviet Union.

642. Reading Seminar in Recent Asian History. (3-0). Credit 3. Prerequisite: Approval of department head.

645. Seminar in Modern Military History. (3-0). Credit 3. Topics in modern military history. Provides broad familiarization in current military history studies. Prerequisite: Approval of department head.

670. Russian-American Relations in Asia Since 1894. (3-0). Credit 3. Evolution of relations in Asia from late 19th century, with background on areas of concern, problems and policies. Prerequisite: Approval of department head.

673. Age of Absolutism and Enlightenment. (3-0). Credit 3. Europe from 1648 to 1789, with particular emphasis upon France. Political history of the age supplemented by examination of economic and social institutions and of the Enlightenment. Prerequisite: Approval of department head.

677. Modern Britain. (3-0). Credit 3. Political, social, cultural, economic and diplomatic development of the United Kingdom in the 20th century. Prerequisite: Approval of department head.

681. Seminar. (1-0). Credit 1. Topics in professional development. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 3 each semester. Individual instruction in selected fields of history. Stresses reports and wide readings in field selected. Prerequisites: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of American or European history.

691. Research. Credit 1 or more each semester. Thesis research. Credit given only upon acceptance of completed thesis. Prerequisites: Approval of department head.

DEPARTMENT OF HORTICULTURAL SCIENCES

D. A. Bender, E. E. Burns, D. H. Byrne, B. G. Cobb, S. D. Cotner, F. J. Dainello, F. T. Davies, Jr., M. Drew, J. D. Hanna, J. L. Johnson, J. A. Lipe, W. N. Lipe, C. G. Lyons, Jr., R. D. Marquard, G. R. McEachern, E. L. McWilliams, J. C. Miller, Jr., K. Patten, H. B. Pemberton, L. M. Pike, D. W. Reed*, S. M. D. Rogers, R. E. Rouse, J. B. Storey, R. M. Taylor, J. L. Tipton, C. D. Townsend**, H. G. Vest, Jr. (Head), A. B. Wagner, Jr., Y.-T. Wang, J. M Zajicek

*Graduate Advisor
**M.Agr. Advisor

FLORICULTURE (FLOR)

The field of research in floriculture with ornamental crops affords excellent opportunities for original work. Studies in the propagation, nutrition, culture, harvesting, grading, marketing and improvement of ornamental plants may be undertaken. Also, monographic studies of ornamental groups and their adaptability to use are suitable problems for investigations.

Many of the problems in this field are basically those of plant response in relation to environment, and students should have adequate preparation in botany, plant physiology, genetics, agronomy, plant pathology, entomology, chemistry and floriculture or horticulture.

Programs of study are available leading to the degrees of master of agriculture and master of science.

609. Taxonomy of Ornamental Plants. (2-2). Credit 3. Families, genera, species and cultivars of horticultural plants; identification, morphological variation, use and adaptability to climatic conditions in the Southwest. Specific problems in horticultural taxonomy, geography, biosystematics and genecology. Prerequisites: BIOL 201, HORT 206 or approval of instructor.*

610. Tropical Foliage Plants. (2-2). Credit 3. Rare and exotic plants of tropical and subtropical regions of world. Identification, adaptation, cultural requirements, propagation and economic importance. Specific problems in taxonomy, physiology and anatomy of these plants. Prerequisite: HORT 320.*

615. Greenhouse Problem Diagnosis. (2-2). Credit 3. Greenhouse design, construction and environmental controls as they relate to crop production. Diagnosis of problems encountered in management and maintenance of greenhouse facilities and in the production and care of plants grown in greenhouses for scientific investigations. Prerequisite: Graduate classification.*

616. Asexual Plant Reproduction. (2-2). Credit 3. Basic scientific principles underlying highly technical practices involved in reproduction of herbaceous and woody ornamental, fruit and vegetable plants by asexual methods. Current developments and techniques in anatomical, morphological, environmental, physiological and chemical factors and their application to commercial asexual plant propagation practices. Prerequisite: Approval of instructor. Cross-listed with HORT 616.

684. Professional Internship. Credit 1 to 4. Program planned to provide professional training in student's particular field of interest. Faculty and employer will supervise the activity. Work-study will be planned as a part of the master of agriculture degree program in greenhouse technology and nursery technology. Prerequisite: Approval of instructor.

685. Problems. Credit 1 to 4 each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of floriculture. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research. (1-0). Credit 1. Design of research experiments in various fields of horticulture and floriculture and evaluation of results with the aid of examples taken from the current scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

*Field trips required for which departmental fee may be assessed to cover costs.

HORTICULTURE
(HORT)

Advanced work in horticulture may be conducted with areas of specialization in fruit production, nut production, vegetable production, ornamental horticulture and nursery crops, and fruit, nut and vegetable processing. Supporting work may be required in several of the related fields such as chemistry, botany, plant pathology, plant physiology, entomology, soils, genetics, nutrition and agricultural engineering. The specific objective of the individual student will guide his or her committee in the choice of courses from the departments mentioned above and others in special cases.

Programs of study leading to the master of agriculture, master of science and doctor of philosophy degrees are available. These degrees are also offered in food science and technology.

601. Nutrition of Horticultural Plants. (3-3). Credit 4. Principles of nutrition related to management practices of fruit, nut, ornamental and vegetable plants; practice in leaf nutrient analysis by atomic absorption and plasma emission spectrophotometry, and autoanalyzer; development of skills in hydroponic nutrition research. Prerequisite: PPHY 313 or approval of instructor.*

602. Environmental Relations of Horticultural Crops. (3-3). Credit 4. Influence of environmental factors on reproductive and vegetative growth and productivity of horticultural crops in the field and greenhouse; cold and chilling damage; heat stress; water quality, stress and adaptation; low and high light stress; and salinity. Prerequisite: PPHY 313 or approval of instructor.

604. Applied Physiology of Horticultural Crops. (3-3). Credit 4. Chemical, biological and environmental factors in growth and differentiation and their application to ornamental, fruit and vegetable crops; growth kinetics; source-sink relations; fruit development; seed development and germination; juvenility; apical dominance; growth retardants; pruning; photoperiodism; flowering; sex expression; and senescence. Prerequisite: PPHY 313, BIOL 453 or approval of instructor.

606. Commercial Orchard Management. (2-6). Credit 4. Horticultural, labor, equipment and economic aspects of commercial peach, pecan and grape production and management, with a computerized cost and return analysis. Prerequisite: Approval of instructor.

615. Origin and Distribution of Horticultural Plants. (2-3). Credit 3. Origin of flowering plants, plant reproduction, species concept, modes of speciation, natural hybridization, chromosome repatterning, polyploidy, agamospermy, plant domestication, crop center of origin and germplasm collection. Prerequisite: Approval of instructor.

616. Asexual Plant Reproduction. (2-2). Credit 3. Basic scientific principles underlying highly technical practices involved in reproduction of herbaceous and woody ornamental, fruit and vegetable plants by asexual methods. Current developments and techniques in anatomical, morphological, environmental, physiological and chemical factors and their application to commercial asexual plant propagation practices. Prerequisite: Approval of instructor. Cross-listed with FLOR 616.

621. Principles and Practices of Horticulture. (3-0). Credit 3. Origin, production and handling of major horticulture crops; greenhouse management, plant propagation, fruit and vegetable production, landscape and floral design; horticulture selection. For horticulture educators, horticulture therapists and teachers of agriculture science. Prerequisite: Six hours of biological science.

644. Food Quality. (3-0). Credit 3. Physical, chemical and biological properties of foods. Fundamental attributes of flavor, color, odor and texture. Esthetic, ethnic and nutritional requirements. Role of additives. Regulatory standards and quality control regimes. Current techniques in food investigations. Cross-listed with FSTC 644.*

681. Seminar. (1-0). Credit 1. Student and staff participation in review of literature and reporting on current developments in research on production and processing of horticultural crops. Required of all graduate students in horticulture and floriculture.

684. Professional Internship. Credit 1 to 4. Program planned to provide professional training in student's particular field of interest. Faculty and employer will supervise the activity. Work-study planned as a part of the master of agriculture degree program in fruit and vegetable production, processing and handling. Prerequisite: Approval of instructor.

685. Problems. Credit 1 to 4 each semester. Individual problems of research not pertaining to thesis or dissertation. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of horticulture. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Research. (1-0). Credit 1. Design of research experiments in various fields of horticulture and floriculture and evaluation of results with the aid of examples taken from the current scientific literature. May be repeated for credit.

691. Research. Credit 1 or more each semester. Research in horticultural problems for thesis or dissertation.

*Field trips required for which departmental fee may be assessed to cover costs.

HUMANITIES

(See Philosophy and Humanities)

DEPARTMENT OF INDUSTRIAL ENGINEERING

INDUSTRIAL ENGINEERING: G. K. Bennett (Head), L. T. Blank, J. J. Congleton, G. L. Curry, B. L. Deuermeyer, R. L. Disney, N. C. Ellis, J. R. English, R. M. Feldman*, J. W. Foster III, M. J. Fox, Jr., A. Garcia-Diaz, J. K. Hennigan, G. L. Hogg (Division Chair), R. D. Huchingson, R. J. Koppa, C. O. Malave, R. J. Mayer, D. A. Mitta, D. T. Phillips, T. Sastri, R. E. Shannon, D. R. Smith, W. E. Wilhelm, C. V. Wootan, M. A. Wortman

BIOENGINEERING: W. A. Hyman (Division Chair), C. S. Lessard, G. E. Miller*, E. M. O'Brien, S. Rastegar, E. J. Rykiel, Jr., P. J. Sharpe, H. Wu

INDUSTRIAL HYGIENE AND SAFETY ENGINEERING: W. L. Johnston, R. B. Konzen*

*Graduate Advisor

The graduate programs in the Department of Industrial Engineering are quite broad and are designed to develop the student's understanding of modern engineering principles, applications and research. The department is comprised of four degree programs: industrial engineering, bioengineering, safety engineering and industrial hygiene. The industrial engineering program offers studies in human factors engineering, management engineering, operations research and applied statistics, and production and manufacturing systems. All of these sub-programs and areas serve as focal points for the academic programs in engineering dealing with man, man and machine, and man and the biological, natural and social environment. The master's degrees available in the Industrial Engineering Department are the master of engineering and master of science in industrial engineering and bioengineering, and the master of science in safety engineering and industrial hygiene. The degree of doctor of philosophy is available in industrial engineering and bioengineering. The department also offers courses and faculty supervision for students pursuing the doctor of engineering degree. The graduate courses listed below indicate the depth of work available in each of these sub-programs and areas.

The graduate research program within the department is equally as broad as the academic program. Research is underway or has been conducted in such diverse areas as assurance sciences, engineering economics, computer aided manufacturing, human factors engineering, management engineering, artificial intelligence, knowledge engineering, manufacturing engineering, operations research and optimization, computer graphics, municipal systems engineering, biomedical engineering, clinical engineering, decision support systems, expert systems, production design engineering, simulation techniques, industrial operations, maintainability engineering, biomechanics, biomaterials, biosystems, medical systems engineering, bioinstrumentation, bionics, ecological systems engineering, industrial hygiene, systems safety engineering, product liability analysis and labor relations.

Facilities for study and research are exceptional. An excellent, fully equipped Computing Services Center provides a laboratory for all students. In addition, research laboratories are available in the deparment in industrial automation, knowledge based systems, bioengineering, industrial hygiene, safety engineering, ecological systems engineering, maintainability engineering, decision support systems, human factors, microcomputers, and work standards and methods design. These laboratories are well equipped and provide students with exceptional research opportunities. Numerous research projects are underway which provide students with a wide range of opportunities to obtain engineering experience in a chosen area as they complete the requirements for their advanced degrees. In addition, the bioengineering program offers a clinical internship as part of its master of engineering option.

Specific requirements for graduate degrees are available on request from the department. Demonstration of the knowledge of a foreign language is not part of the minimum requirements for a doctor of philosophy degree in the Department of Industrial Engineering.

BIOENGINEERING
(BIEN)

601. Foundations of Bioengineering Analyses. (3-0). Credit 3. Analysis of biomedical and ecological processes using methodologies from mathematical physics. Applications include differential geometry problems in biophysics, divergence of population flow processes, heat and material flow in biological systems. Prerequisite: MATH 308.

602. Instrumentation and Measurement in Biological Systems. (3-3). Credit 4. Information processing from biological systems; interface matching. Transducers commonly used in bioengineering as the interface between biological signals and instrumentation systems. Prerequisites: ELEN 331 or equivalent; BIEN 401 or approval of instructor.

603. Information Processing in Bioengineering. (3-3). Credit 4. Methods for evaluating alternative approaches in computing systems for biomedical applications. Provides familiarity with the wide variety of existing software and available programming resources.

604. Application of Field Theory in Bioengineering. (3-0). Credit 3. Application of classical field theory in biomedical and biosystems engineering including bioelectrostatic and biomagnetostatic fields, theory and application of magnetoencephalogram as well as ecological application to interference among plants and animals. Prerequisite: BIEN 601.

607. Clinical Engineering. (3-0). Credit 3. Responsibilities, functions and duties of the hospital based biomedical engineer including program organization, management, medical equipment acquisition and use, preventive maintenance and repair and hospital safety. Prerequisite: Approval of instructor.

610. Medical Ultrasonics. (3-0). Credit 3. Physical principles of diagnostic and therapeutic ultrasound. Clinical equipment. Diagnostic and therapeutic protocol. Biological effects of ultrasound. Prerequisites: PHYS 219 or equivalent and 3 hours in human physiology.

612. Experimentation. (2-3). Credit 3. General concepts forming the basis of the scientific method and design of experiments. Analytical instrumentation and measurement methods useful in biomedical research. Criteria for the selection, care and use of experimental animals and human subjects in biomedical research. Prerequisite: Approval of instructor.

614. Modeling of Biological Systems. (3-0). Credit 3. Principles, objectives and approaches to describing physiological phenomena with mathematical models with emphasis on mammalian systems. Prerequisite: Approval of instructor.

619. Engineering Analyses of Artificial Internal Organs. (3-0). Credit 3. Design, development and evaluation of artificial internal organs. Prerequisites: VTPP 335 or equivalent; BIEN 452.

635. Biomaterials Compatibility. (3-0). Credit 3. Relevance of mechanical and physical properties to implant selection and design. Effect of the body environment on metallic, ceramic and plastic materials. Rejection mechanisms used by the body to maintain homeostasis. Prerequisite: Approval of instructor.

638. Control Mechanisms in Living Systems. (3-0). Credit 3. Application of control theory to the dynamic characteristics of electro-physiological and biochemical processes and to the natural and artificial maintenance of homeostasis in living systems. Prerequisites: BIEN 401; MATH 602; VTPP 335; or approval of instructor.

651. Biochemical Engineering. (3-0). Credit 3. Integration of principles of engineering, biochemistry and microbiology; application to the design, development and improvement of industrial processes that employ biological materials. Prerequisite: Approval of instructors. Cross-listed with AGEN 651 and CHEN 651.

673. Analysis of Biosystems. (3-0). Credit 3. Non-human biological systems; structure and function from a systems engineering viewpoint. Derivation of rate kinetics from physical and chemical laws. Introduction to von Foerster equation describing age-dependent population dynamics and Leslie matrix. Prediction of growth, development, reproduction and mortality of poikilothermic organisms under varying environmental conditions. Prerequisites: One computer course and approval of instructor.

674. Modeling of Biosystems. (3-0). Credit 3. Computer modeling of biological systems based on concepts introduced in BIEN 673. Use of models for pest management decisions, environmental impact assessment, crop productivity and extension functions. Use of on-site minicomputers with APL capability. Prerequisite: BIEN 673.

675. Tracer Kinetics and Compartmental Analysis. (4-0). Credit 4. Formal and engineering foundation for tracer data analysis for model validation. Theoretical and mathematical basis for compartmental analysis in the biosystems and biomedical fields. Prerequisites: MATH 308; CPSC 203.

681. Seminar. (1-0). Credit 1. Designed to permit student to broaden capability, performance and perspective in bioengineering via his or her own formal presentation and by presentations from other professionals.

684. Professional Internship. Credit 1 or more each semester. Training under the supervision of practicing engineers in settings appropriate to the student's professional objectives. Prerequisites: Approval of student's Advisory Committee chairman and head of Bioengineering Program.

685. Problems. Credit 1 to 4 each semester. Allows students the opportunity to undertake and complete, for credit, limited investigations not included within thesis or dissertation research and not covered by other courses. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. In-depth study in areas relating to specific student interests and recent advances in bioengineering. Topics will normally vary and this course may be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

INDUSTRIAL ENGINEERING (INEN)

601. Location Logistics of Industrial Facilities. (3-0). Credit 3. Selection of the optimal locations of industrial plants and distribution centers through analytical modeling of the costs of inventory storage, transportation, utilities, labor supply and other cost components. Prerequisites: INEN 303, 416 or 600.

602. Assurance Sciences. (3-0). Credit 3. Introduction to the random processes as a basis for studying topics in reliability, maintainability, quality control, design of experiments and forecasting. Prerequisites: INEN 620 and STAT 212 or 601.

603. Human Relations and Collective Bargaining in Industry. (3-0). Credit 3. Labor management relationship and human relations problems encountered during the three stages of union development, i.e. hostility, transition and cooperation; problems arising from contract administration and encountered at the bargaining table; simulation games. Cross-listed with MGMT 650.

604. Advanced Work Methods and Measurement. (2-3). Credit 3. Basic techniques and advanced concepts in work methods and measurement systems and their application; line balancing, cost reduction plans, standards for combined manual and decision tasks, computerized determination of standards, physiological criteria of work measurement, and management of methods and standards. Prerequisite: INEN 304 or approval of instructor.

605. Material Handling Systems. (3-0). Credit 3. Analysis and design of integrated material handling systems; automatic storage and retrieval of unit loads, and identifying and establishing boundary conditions on key parameters required to specify the desired system required for equipment vendors to design appropriate hardware. Prerequisite: INEN 416 or approval of instructor.

606. Collective Bargaining in the Public Sector. (3-0). Credit 3. Status of collective bargaining in the public sector; federal, state, county and municipal levels. Special problems associated with such special groups as federal employees, teachers, police officers and fire fighters, nurses and other state, county and municipal employees. Nature of grievances, and forms of impasse resolution and their impact on the various collective bargaining and/or professional negotiations. A simulation game is a course requirement.

608. Industrial Case Analysis. (3-0). Credit 3. Practice in applications of principles to the solution of actual case problems involving broad management decisions. Prerequisite: INEN 303, 304, and 315 or approval of instructor.

611. Arbitration Procedures in Work Practices. (3-0). Credit 3. Status of arbitration in labor relations. Causes of grievances and means of reducing the frequency of cases going into arbitration. Procedures, techniques and rules of evidence in arbitration. Sensitive areas of collective bargaining. Case studies in arbitration. A simulation game is a course requirement. Cross-listed with MGMT 652.

612. Design by Reliability. (3-3). Credit 4. Quantitative reliability analysis in engineering design. Reliability methods applicable to design: component reliability determination, system reliability model analysis, life testing stress/strength analysis, and fault tree analysis. Prerequisites: INEN 620 and STAT 212 or 601.

613. Engineering Data Analysis. (3-0). Credit 3. Selected topics in probability and data analysis for quantitative decision-making in engineering problems. Measurement principles, data collection and data analysis required to solve engineering problems. Introduction to courses in the assurance sciences-reliability, maintainability, quality control and experimental design. Note: This course may not be used for degree credit in industrial engineering. Prerequisite: MATH 253 or equivalent.

614. Advanced Quality Control. (3-0). Credit 3. Advanced methods applied to quality control. Acceptance sampling plans from the classical lot by lot attribute plan to sophisticated multi-lot dependent plans. Classical treatments and recent developments in process control. Evaluation, design and maintenance of quality control programs. Prerequisite: STAT 212 or 601.

615. Production and Inventory Control. (2-3). Credit 3. Development and application of techniques for forecasting, requirements, planning, inventory management and production control by means of statistical analysis, optimization methods, simulation techniques and computerized execution of production and inventory control functions. Prerequisites: INEN 315 and 622 and STAT 212 or 601 or equivalents.

616. Design and Analysis of Industrial Experiments. (3-0). Credit 3. Fundamental theory, concepts and procedures required in the efficient design and analysis of industrial statistical experiments. Emphasis on formulations and applications meaningful in actual practice. One-factor experiments with and without restrictions on randomization, Latin and other squares, factorial experiments, full and fractional two-level factorial experiments, blocking in factorial designs and response surface methodologies. Prerequisite: STAT 212 or 601.

617. Quantitative Methods in Maintainability. (3-0). Credit 3. Techniques of operations research and engineering data analysis to problems of system maintainability and maintenance. Models of repair and failure, wearout processes, maintainability demonstration and warranties, maintenance and inspection policies, and spare parts policies. Prerequisites: INEN 620 and STAT 212 or 601.

618. Stochastic Processes in the Assurance Sciences. (3-0). Credit 3. Basic stochastic processes necessary to deal with advanced problems in reliability, maintainability and other related areas. Markov decision theory, optimal stopping problems, renewal theory and semi-Markov decision theory. Prerequisite: INEN 602.

619. Analysis and Prediction. (3-0). Credit 3. Analysis of time dependent by smoothing methods, regression, Bayes methods, time series analysis and autoregressive moving average methods. Methods applied to industrial and production forecasting problems. Prerequisites: INEN 602 and STAT 212 or 601 or equivalents.

620. Survey of Operations Research. (4-0). Credit 4. Provides specific capabilities in operations research techniques so that extensions and modifications can be made for practical applications. Mathematical models for optimizing decisions using probability methods, linear and quadratic programming, dynamic programming, simulation and queuing theory. Note: This course may not be used for degree credit in industrial engineering. Prerequisites: INEN 320 and STAT 212 or 601.

622. Applied Linear Programming. (3-0). Credit 3. Understanding of mathematics associated with linear programming and proficiency in recognition, definition and solution of all types of applied linear programming problems by manual and computerized methods. Application of this methodology in operations research and industrial engineering problems. Prerequisite: INEN 620 or equivalent.

623. Nonlinear and Dynamic Programming. (3-0). Credit 3. Understanding of mathematics involved and a proficiency in recognition, definition and solution of quadratic, dynamic and other nonlinear programming problems by manual and computerized methods. Application of methods to problems in operations research and industrial engineering. Prerequisites: INEN 620 or equivalent.

624. Applied Distribution and Queuing Theory. (3-0). Credit 3. Queuing theory and its applications; single and multiple channels, priorities, balking, batch arrivals and service, and selected non-Markovian topics. Applications; statistical inference and design and control of queues. Prerequisite: INEN 602.

625. Simulation Methods and Applications. (2-3). Credit 3. Fundamental methods and methodology of systems simulation. Random number generation, random deviate generation, clock routines and statistical analysis of simulation models. Discrete simulation, continuous simulations and combined simulations. Prerequisite: INEN 422.

626. Model Building and Applications of Operations Research. (3-0). Credit 3. Problem-solving environment exposing students to a variety of unstructured problems requiring organization, formulation and solving an appropriate model. Selection and use of an efficient technique. Computer solution procedures. Selected readings in current literature. Prerequisites: Four courses within the INEN 620 and 660 series or equivalent or approval of instructor.

627. Engineering Analysis for Decision Making. (3-0). Credit 3. Principles and application of techniques in analysis of decision processes involving engineering systems under uncertainty. Areas of utility and information theory as related to quantification of information for decision-making. Prerequisites: INEN 613, 620 and 666 or approval of instructor.

629. Engineering Optimization. (2-3). Credit 3. Nonlinear optimization from an analytical and numerical standpoint. Necessary and sufficient conditions, Langrangian multipliers, constrained derivatives, special forms, unidimensional search, gradient based techniques, conjugate directions, derivative free search, penalty functions, projection methods, linearization methods and current literature. Prerequisites: INEN 622 and 623, or approval of instructor.

630. Human Operator in Complex Systems. (3-0). Credit 3. Basic understanding of the theory and practice of human factors engineering. Topics are presented within the framework of humans as a functioning systems and their requirements when incorporated in hardware and software systems.

631. Engineering Man-Machine Interface II. (3-0). Credit 3. Understanding of the man-machine interface and development of the capability of applying human performance data in the design of equipment and facilities (controls, displays, speech technology and workplace). Prerequisite: Approval of instructor.

632. Human Factors Engineering in System Design. (3-0). Credit 3. Capability of functioning as a human factors engineer in the system design and development environment. Applications of human factors to design and evaluation of man-machine systems. Prerequisite: Approval of instructor.

633. Human Factors Laboratory. (1-3). Credit 2. Various techniques of measuring and/or monitoring human performance variables under environmental stress. Control of environmental variables necessary to simulate real life problems and conditions. Familiarizes student with instrumentation and preparation of lab reports. Prerequisite: INEN 637.

634. Man-Machine Systems Engineering. (3-0). Credit 3. Industrially oriented human engineering tool for systematic analysis, identification and evaluation of man-machine systems leading to development of human factors data for design of hardware; personnel subsystem and system procedures for operation and maintenance. Prerequisite: Approval of instructor.

635. Human Information Processing. (3-0). Credit 3. Perceptual and cognitive issues as related to the design of man-machine systems. Value of including a human in the system rests upon the unique ability to translate sensed data into meaningful command signals. Prerequisite: Approval of instructor.

636. Biological Control System Analysis. (3-0). Credit 3. Current advances in practical biomechanics and ergonomics in industry in combating musculoskeletal injury and illness, demonstrations of the positive effects of redesign of job requirements, hand tools, chairs, manual material handling tasks, machine controls and workspace arrangements. Prerequisite: Approval of instructor.

637. Human Factors Engineering. (3-0). Credit 3. Human factors methods, models and problem areas; industrial ergonomics and human performance criteria for work in stressful environments. Prerequisite: Approval of instructor.

638. Human Operator as a Systems Controller. (3-0). Credit 3. Understanding of the theory and application of the human control process in both manual and automatic control systems, giving the student a capability to develop human factors engineering requirements for the design of control systems. Prerequisite: Approval of instructor.

639. Human Factors in Expert Systems Development. (3-0). Credit 3. Exploration of expert systems building tools; application of human factors criteria in the knowledge engineering task of designing knowledge-based systems; developing and using a small expert system for the industrial environment. Prerequisite: INEN 630 or approval of instructor.

653. Robot Applications in Batch Manufacturing. (2-3). Credit 3. Robotic concepts for use in manufacturing systems; industrial robots and their physical and software control structures; limitations of robots for manufacturing and the impact of robots on production planning; methods for the design and implementation of a robotic work cell for various applications. Prerequisites: INEN 615, 666 or equivalent.

654. Computer Integrated Manufacturing. (2-3). Credit 3. The systems perspective of a computer integrated manufacturing system; manufacturing and its various levels and the planning and control of product movement through the production system in the context of using realtime control, multiprocessor systems, network architectures and databases. Prerequisite: INEN 615 or 315.

661. Network-Based Planning and Scheduling Systems. (3-0). Credit 3. Deterministic and stochastic network flow analysis; the science and art of network modeling, minimal cost flow, shortest route, max-flow and the out-of-kilter algorithm. Recent developments in constrained network analysis and stochastic queueing networks and a number of real-world models. Extensive use of computerized algorithms. Prerequisite: INEN 622.

663. Engineering Management Control Systems. (3-0). Credit 3. Integration of human relations, planning and control concepts, systems analysis and design, and principles of management oriented toward engineering functions within an organization. Organizational design and administration as they impact along the product life cycle, i.e., research, design, development, production and use.

664. Principles of Scheduling. (3-0). Credit 3. Sequencing and scheduling, routing and dispatching, and resource constrained scheduling applied to job shops, flow shops and projects. Mathematical programming, queuing and simulation used. Computational complexity of scheduling algorithms. Prerequisites: INEN 622 or 623 or approval of instructor.

665. Production and Inventory Control Modeling. (3-0). Credit 3. Modeling and analysis techniques used to study inventory problems. Review of stochastic processes, convex programming and dynamic programming. Prerequisites: INEN 602 and 615.

666. Engineering Economy. (3-0). Credit 3. Fundamental concepts and advanced techniques of engineering economic analysis. Evaluation of alternative capital investments considering income taxes, depreciation and inflation. Discounted cash flow analysis of competing projects, break-even analysis and determination of rate of return on investment. Risk and uncertainty in engineering analysis. Prerequisite: INEN 303 or equivalent.

681. Seminar. (1-0). Credit 1. Opportunity to present research in a professional atmosphere. Presentations are not restricted to thesis or problem research. Presentations found unacceptable by faculty representative must be repeated with a different subject. Acquaints the student with departmental research activities and procedures in documenting research. Normally taken the first semester in graduate program.

684. Professional Internship. Credit 1 or more each semester. On-the-job training under supervision of practicing engineers in settings appropriate to professional objectives. Prerequisite: Approval of committee chair and department head.

685. Problems. Credit 1 to 4 each semester. Special topics not within scope of thesis research and not covered by other formal courses. Prerequisite: Graduate classification in industrial engineering.

689. Special Topics in . . . Credit 1 to 4. In-depth study in areas relating to specific student interests, recent advances and societal problems in industrial engineering. Topics will normally vary and this course may be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research in industrial engineering field; content and credit dependent upon needs of individual student.

SAFETY ENGINEERING
(SENG)

670. Industrial Safety Engineering. (3-0). Credit 3. General concepts and techniques of safety engineering upon which more detailed and advanced applications may be based; applications of safety engineering principles to industrial and commercial systems; the concept of designing optimally safe systems.

671. Product Safety Engineering. (3-0). Credit 3. Provides specialized emphasis required to develop within a student the ability to function in the product design as a specialist in product safety engineering; safety engineering and human factors principles are focused on specific problems in product safety and liability considerations; application of system safety principles.

672. Safety Engineering in Facilities Design. (3-0). Credit 3. Design of buildings, processes and auxiliary equipment from the standpoint of loss occurrence and control. Fire protection, environmental health and accident prevention principles are focused on specific problems of loss exposure as related to the facility design. Protective procedures and methods of preventing loss of people and facilities.

674. System Safety Engineering. (3-0). Credit 3. Current system safety engineering analysis techniques; failure mode and effect and fault tree analysis. Engineering economic analysis is reviewed to develop skills for the safety engineer in presenting alternate solutions to management.

677. Fire Protection Engineering. (2-3). Credit 3. Theory of combustion, characteristics of flammables, fire resistance, fire spread, fire protection principles, public and private fire service organization and equipment; automatic extinguishing systems. Fire protection analysis and design projects.

678. Problems in Safety Engineering. (3-0). Credit 3. Techniques of problem identification and solution based on analysis of input data. Current literature relative to accident causation, hazard identification, risk acceptance, property-business interruption losses and risk management. Preparation of management reports.

680. Industrial Hygiene. (3-0). Credit 3. Recognition of environmental stresses present in man-machine-environment systems and the effect of these stresses on human performance, safety and health; chemical, physical, ergonomic and biological exposures, manufacturing systems, materials and operations.

681. Seminar. (1-0). Credit 1. Formal presentations in industrial hygiene and safety engineering by students and professional industrial representatives.

682. Instrumentation for Industrial Hygiene. (3-3). Credit 4. Evaluation of environmental stress factors present in man-machine-environment systems. Introduction to quantitative and qualitative instrumentation used in industrial hygiene. Development of in-depth evaluation techniques as a precursor to the design of engineering controls. Prerequisite: SENG 680 or approval of instructor.

683. Evaluation and Control of the Occupational Environment. (3-3). Credit 4. Detection, evaluation and control of chemical, physical and biological agents prevalent in manufacturing, construction and mercantile operations. Evaluation procedures and control technology emphasized. Guest speakers and field trips to local industry. Prerequisites: SENG 680 and 682 or approval of instructor.

685. Problems. Credit 1 to 4 each semester. Investigation of topics not within the scope of thesis or dissertation research and not covered by other formal courses.

686. Acoustics and Noise Control. (2-3). Credit 3. Physical, physiological and psychological aspects of noise; evaluation and control of the noise problem in the work environment and community. Source, path and level of noise; acoustical properties of materials; damage-risk criteria for hearing; and criteria for noise and vibration in communities, buildings and vehicles.

687. Industrial Ventilation. (2-3). Credit 3. Development of design principles and application of natural, dilution and local exhaust ventilation to control occupational exposures to conditions conducive to the development of occupational disease. Prerequisites: MATH 209; PHYS 201, 202, or equivalent.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of safety engineering and industrial hygiene. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research in industrial hygiene, safety engineering or related topics for thesis or dissertation.

DEPARTMENT OF INDUSTRIAL, VOCATIONAL AND TECHNICAL EDUCATION

G. E. Baker*, R. Q. Brackett, Jr., D. L. Clark* (Head), M. E. Dennis* (Coordinator, SAED), G. D. Gutcher*, D. L. Householder*

*Graduate Advisor

The Department of Industrial, Vocational and Technical Education, within the College of Education, provides the setting for graduate study through the doctorate. Areas of study include industrial/technology education, safety education and industrial vocational education. Graduate degree programs can be developed to prepare individuals for professional careers related to education and training in both school and non-school settings. Course work leading to certification in occupational orientation, vocational guidance and vocational administration or supervision is available through the department.

Master's degree students seeking preparation for training and development positions in the corporate sector or in governmental agencies may elect to include that specialization within their degree programs. The specialization includes courses in the development, operation, management and evaluation of training and development programs, strategic planning, communications, marketing and organizational behavior, and a training and development internship appropriate to the major field of study.

The department participates in interdisciplinary planning, research and evaluation offered in cooperation with other departments in the College of Education. Prospective doctoral students who wish to develop an interdisciplinary supporting field in educational planning, research and evaluation should examine the interdisciplinary studies option which is presented in the description of graduate courses in interdisciplinary education. Within the framework of existing doctoral programs of the departments in the College of Education, individuals may pursue an area of emphasis in higher education.

Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling or administering in junior and community colleges, technical colleges or universities. Within the framework of a number of doctoral programs at Texas A&M University, it is possible to pursue a concentration in higher education as a cognate area. Courses available include: EDAD 610, 625, 626, 655; EDCI 601, 606, 649; EPSY 669, 670; INED 604; ADEX 645 and SAED 624.

INDUSTRIAL EDUCATION (INED)

Graduate programs and courses in industrial/technology education provide the framework for degree requirements at both the master's and doctoral levels. The formal course work, supplemented with problems courses, internship experience and research and development opportunities, is designed to provide the student with the opportunity to develop the skills and knowledge generally required of industrial educators, researchers, program directors and departmental administrators in various educational and technical settings.

601. History and Philosophy of Industrial Education. (3-0). Credit 3. Leaders, movements and agencies; economic, social and philosophical factors which have contributed to the development of industrial/technology and vocational education in the U.S.

603. Supervision of Vocational and Industrial Education. (3-0). Credit 3. Problems of administrators and supervisors of programs in industrial arts/technology and vocational education.

604. Occupational Programs for Community Colleges and Technical Schools. (3-0). Credit 3. Kinds, purpose, size, accreditation, growth and teaching problems in community colleges, technical institutes and adult schools; organization and presentation of industrial subject material in these schools.

606. Management of Post-Secondary Industrial Education Departments. (3-0). Credit 3. Problems of industrial education programs in community colleges, junior colleges, technical institutes, colleges, universities and private business and industry.

609. Innovative Programs in Industrial Arts/Technology Education. (2-3). Credit 3. Developing programs in industrial arts/technology education. Design and organizational strategies for teaching these programs.

616. Methods of Teaching Industrial/Technology Education. (3-0). Credit 3. Selection and use of appropriate instructional strategies in industrial/technology education.

618. Tests and Measurements in Industrial and Vocational Education. (3-0). Credit 3. Testing and measuring strategies and their applications to industrial and vocational education subjects.

620. Human Relations in Education and Industry. (3-0). Credit 3. Establishing and maintaining effective working relationships among teachers, trainers and trainees in educational, industrial and business settings.

626. Classroom Management and Shop Organization. (3-0). Credit 3. Organization of procedures and facilities to facilitate learning, issuing procedures for tools and materials, keeping material inventory, using assignment and progress charts, using student leadership in nonteaching class and laboratory routine, and keeping records.

INDUSTRIAL, VOCATIONAL AND TECHNICAL EDUCATION (IVED)

Courses that are generic to all programs in the department are listed under the IVED prefix and may be used on degree options in each program area.

627. Research and Development in Technical Education. (3-0). Credit 3. Methods of conducting research programs in industrial/technology, vocational and technical education.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research, contemporary trends and professional issues in industrial/technology and vocational education. May be repeated for credit.

684. Professional Internship. Credit 1 to 6 each semester. A university-directed internship in educational and industrial practices for the prospective industrial/technology education teacher, supervisor, administrator or researcher. Selected educational or industrial settings appropriate to the student's professional objectives will be used. Prerequisite: Approval of chair of Advisory Committee and of department head.

685. Problems. Credit 1 to 4 each semester. Designed to enable the student to undertake and complete with credit limited investigations not within thesis research and not covered by any other course.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of industrial/technology education. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Industrial and Vocational Education Research. (3-0). Credit 3. Theory and design of research, preparation of research proposals, evaluation of contemporary research, preparation of research reports in industrial/technology and vocational education. Prerequisite: IVED 627.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

SAFETY EDUCATION
(SAED)

As a part of the industrial education program, master's and doctoral students may emphasize courses in safety education. These courses interface with industrial education, engineering, psychology, business administration, the physical and biological sciences, educational curriculum and instruction, physical education and educational administration. Supporting areas are permitted in these and other areas.

601. Behavioral Factors in Traffic Safety. (3-0). Credit 3. Personality factors related to unsafe driving behavior. Effect of attitudes, motivations and adjustment on behavior. Principles and methods appropriate in identifying, understanding and modifying unsatisfactory attitudes and behavior.

604. Alcohol and Traffic Safety. (3-0). Credit 3. Relationship between the consumption of alcohol and its effect upon traffic safety. Role of traffic safety education in educating drivers to the risks and problems involved in drinking and driving.

608. Issues and Trends in Safety Education. (3-0). Credit 3. Current issues and trends in safety education. Research and development affecting safety education profession.

610. Administration of Safety Education Programs. (3-0). Credit 3. Safety education programs at national, state and local levels; administrative, instructional and supervisory aspects of the programs in education and industry.

620. Traffic Safety Communications. (3-0). Credit 3. Specialized problems related to traffic safety communications in a transportation oriented society. Design and operation of a communication process to better understand and influence driver behavior. Planning and managing public information and community support program.

624. School and College Accident Prevention. (3-0). Credit 3. Accident prevention and control programs for educational institutions; human, environmental and legal factors affecting program development, implementation and management.

628. Professional Development in Safety Education. (3-0). Credit 3. Problems of safety education at the university level. Review of related research. Development of representative model curricula for the preparation of safety education personnel.

630. Traffic Safety Education Innovations. (3-2). Credit 4. Recent traffic safety education innovations and their applications for improving the quality of classroom and laboratory instruction. Prerequisite: SAED 427 and 428 or approval of instructor.

631. Traffic Safety Education and the Disabled. (2-2). Credit 3. To prepare traffic safety educators in procedures to instruct physically disabled persons in driving techniques, evaluate adaptive equipment and critique research involving the physically disabled. Prerequisites: SAED 427 and 428 or approval of instructor.

633. Instruction and Techniques in Safety Education Evaluation. (3-0). Credit 3. Measurement and evaluation as related to safety education functions, projects and programs. Unique nature of safety education programming and evaluation designs most appropriate for determining program effectiveness. Prerequisites: Basic courses in statistics and research design.

641. Highway Traffic Accident Reconstruction. (3-0). Credit 3. Theory and practice of analyzing physical damage to vehicles and roadway, and studying accident reports and testimony of survivors and witnesses to determine and reconstruct what occurred in highway traffic accidents.

681. Seminar. (1-0). Credit 1. Group study and discussion of the role of safety education in society. Prerequisite: Approval of instructor.

684. Professional Internship. Credit 1 to 6. Supervised graduate practicums, observations and internships in the various fields of safety education. Prerequisites: Approval of instructor.

685. Problems. Credit 1 to 6. Supervised experiences in performing research appropriate to career goals. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of safety education. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Prerequisite: Approval of committee chairman.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of committee chairman.

INTERDISCIPLINARY EDUCATION

P. T. Beatty*, L. A. Bonham, M. L. Burger*, W. A. Carter*, F. E. Clark*, K. E. Paprock*, L. P. Rieber*, D. F. Seaman* (Coordinator), B. N. Stone*, R. D. Zellner* (Coordinator, EDTC)

*Graduate Advisor

Faculty from other departments in the College of Education and from departments in the College of Agriculture and Life Sciences also teach courses and serve as committee members and Graduate Advisors.

Interdisciplinary education within the College of Education provides the setting for graduate study in the areas of adult and extension education and educational technology.

The program in adult and extension education leads to the master of science, master of education, doctor of education or doctor of philosophy degree. The program provides for the professional preparation of administrators, staff development specialists, teachers and professors of adult education, research personnel, administrators for youth and human service agencies, deans and directors of continuing education, adult literacy personnel and educational gerontology specialists.

Educational technology offers a master of education degree and is designed as a supporting field for doctoral and master's students who are majoring in other disciplines. The program stresses a systems approach to education and communication with a focus on the uses of current technologies, particularly computers and media with related applications in the development of instructional materials and techniques. Courses are intended to provide students with diverse experiences in a variety of instructional settings. The courses are open to individuals who desire to improve their teaching skills or who intend to seek employment in education, government or industry.

Classes are also taught which have college-wide and university-wide appeal. These include courses in research methodology, grantsmanship and women in leadership.

Courses in higher education offer doctoral students an additional dimension of professional mobility if they are interested in higher education settings as part of their career goals. Depending on the student's selection of courses, he or she may prepare for careers in teaching, counseling, or administering in junior and community colleges, technical colleges, or universities.

An area of specialization is also available for master's degree students seeking preparation for training and development positions in the corporate sector (profit or not-for-profit), social service or other government agencies. This specialization includes courses in the development, operation, management and evaluation of training and development programs, strategic planning, communications, marketing and organizational behavior, and an internship appropriate to the major field of study.

ADULT AND EXTENSION EDUCATION (ADEX)

630. Adult Learning. (3-0). Credit 3. Research and theory in adult learning. Factors influencing the adult learning process.

631. Foundations for Lifelong Learning. (3-0). Credit 3. Fundamental concepts and definitions relating to lifelong; major historical developments and philosophical roots of adult education; diverse institutional commitments and response to adult learner needs; administrative, programming and instructional practices in the field; emerging issues in adult education. Prerequisite: Graduate classification.

632. Methods of Adult Education. (3-0). Credit 3. Theory and practice of teaching in adult education. Standard techniques as well as more innovative strategies; programmed instruction, simulation and micro-teaching.

633. Adult Literacy Education. (3-0). Credit 3. Important aspects of implementing literacy programs for adults; funding, recruiting, placement, counseling and using community resources.

636. Working with Adult Groups. (3-0). Credit 3. Development of skills for facilitating productivity in task-oriented groups of adults. Issues, problems and concepts frequently encountered, and potential solutions.

638. Contemporary Issues in Adult Education. (3-0). Credit 3. Pressing contemporary issues facing adult educators. Analyzing issues and seeking approaches to their resolution.

642. Program Development in Adult Education. (3-0). Credit 3. Conceptual tools needed to develop educational programs for adults in a variety of settings. Concepts of planning, implementation and evaluation.

645. Community Services in Higher Education. (3-0). Credit 3. Procedures for organizing and developing a community services program in a college setting. Organizing, financing, publicizing, staffing, evaluating and other relevant activities. Two field trips required for which departmental fee may be assessed to cover costs.

647. Education for the Older Adult. (3-0). Credit 3. Older adults as unique learners — defining specific physical and psycho-sociological differences between older adults and other learners. Educational implications of specific needs and current educational programs to meet those needs.

660. Community Development Education. (3-0). Credit 3. Preparation in the area of community development; role of education; social, economic and political aspects.

664. Volunteer Staff Development. (3-0). Credit 3. Principles of volunteer staff development and use in adult and youth education programs.

EDUCATIONAL TECHNOLOGY (EDTC)

613. Utilization of Instructional Materials. (2-2). Credit 3. Communications; senses of hearing and seeing in teaching-learning processes. Selection, preparation, use and evaluation of instructional materials.

621. Graphic Communication. (3-0). Credit 3. Application of research findings and design criteria to graphic communication design techniques. Techniques of preparation and use of programmed slide sets, filmstrips and motion pictures and their application in instructional systems.

625. Organization and Administration of Learning Resources. (3-0). Credit 3. Planning, coordination and evaluation of local book and non-book learning resource services. Acquisition of materials and equipment.

631. Instructional Television. (3-0). Credit 3. Use of television in instructional systems. Program design and content specification.

641. Message Design. (3-0). Credit 3. Systematic application of task and learner analysis, research findings and design criteria to the design of instructional materials.

645. Classroom Applications of Microcomputers. (3-0). Credit 3. Microcomputer applications (drill, practice, tutorial and simulation) using text, sound and graphics for education and training; computer literacy (hardware/software) for teachers and trainers. Prerequisite: Graduate classification.

651. Computer Assisted Instruction. (3-0). Credit 3. Design of computer delivered instruction. Basic applications of task analysis, learning theory and programming principles to frame construction and sequencing. Relevant computer languages. Preparation of linear and nonlinear CAI programs.

654. Instructional Design: Techniques in Educational Technology. (3-0). Credit 3. Introduces systems approach to instructional design with focus on the functions of systems models in planning, developing, and evaluating instruction; use of instructional development models which systematically assure proper instructional design; participants will develop instructional products individually and in groups; a strong theoretical foundation utilized. Prerequisite: Approval of instructor.

660. Interactive Video: Production and Utilization. (3-0). Credit 3. Survey of the fundamental principles of interactive video design and production; focus on practical application of television production techniques and computer programming skills using authoring languages; experience producing materials for interactive video disc development. Prerequisites: EDTC 631 and 645 or approval of instructor.

662. Computer Utilization in Educational Research and Practice. (3-0). Credit 3. Use of computers for application in a variety of educational and research settings; activities will include student/subject monitoring, hardware use and design, automatic data collection; techniques of storage, retrieval, transmission and analysis. Projects will relate to students' major area of study. Prerequisite: EDTC 645 or approval of instructor.

664. Instructional Management Systems for Education and Training. (2-2). Credit 3. Analysis of instructional management needs associated with educational and training programs and of the computer-based management systems in the management process; issues concerning design, development, implementation and evaluation of those systems. Prerequisite: EDTC 645.

681. Seminar. (1-0). Credit 1. Problems pertinent to educational technology professionals, including: learning resource specialists, school librarians, teachers, administrators, consultants and trainers. Recent developments in application areas, structure and scope of the profession.

683. Practicum in Educational Technology. (0-9). Credit 1 to 3. Supervised experience in applied area of educational technology; student will plan and develop an integrative product relating to educational technology theory, practice and equipment. Prerequisite: Approval of instructor.

684. Professional Internship. Credit 1 to 6. Supervised experiences in performing professional functions appropriate to career goals. Prerequisites: Application one month prior to registration and approval of instructor.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in instructional technology not within thesis research and not covered by any other course. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of educational technology. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Educational Technology Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of educational technology; communication of research proposals and results; review of literature and evaluations of current research. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Prerequisite: Approval of major advisor.

692. Professional Study. Credit 1 or more each semester. Approved professional study or project undertaken as the terminal requirement for doctor of education degree; preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of instructor.

INTERDISCIPLINARY EDUCATION (IDED)

657. Administration and Supervision in Cooperative Extension. (3-0). Credit 3. Administration and supervision of cooperative extension at the state, district and county levels; roles of administrators in coordinating all functions of the organization, particularly those affecting personnel.

675. Women and Organizational Leadership. (3-0). Credit 3. Historical, theoretical, ethical and legal issues relevant to women leaders in organizational contexts; skills development and practical approaches to effective leadership.

679. Procurement and Management of Contracts and Grants. (3-0). Credit 3. Funding sources that support research and development activities; methods of securing funding; and management of funded projects. Basic knowledge, skills and sensitivities needed to secure and manage projects supported through contracts and grants. Prerequisite: Graduate classification.

681. Seminar. (1-0). Credit 1. Problems pertinent to vocational, adult and cooperative extension education. Recent developments and research in appropriate areas.

682. Seminar in . . . (1-0). Credit 1. Knowledge, skills and attitudes in interdisciplinary education. Specific topics will be assigned for each seminar offered. May be repeated for credit.

684. Professional Internship. Credit 1 to 6. Supervised experiences in performing professional functions appropriate to career goals. Prerequisite: Approval of program coordinator.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the fields of adult, vocational, or cooperative extension education.

687. Proseminar: Principles of Professional Practice in Education. (3-0). Credit 3. Exploration of major principles and hallmarks of professional practices in the field of education; foundations for effective decision making and leadership in diverse settings examined; team taught.

688. Proseminar: Analysis of Critical Issues in Education. (3-0). Credit 3. Exploration of a critical issue in the field of education from an interdisciplinary perspective; skills developed in analyzing an issue, exploring its impact upon diverse educational settings, formulating positions and seeking alternative solutions; team taught.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of interdisciplinary education. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Interdisciplinary Education Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of interdisciplinary education. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

692. Professional Study. Credit 1 or more each semester. Approved professional study of project undertaken as the terminal requirement for doctor of education degree. Preparation of a record of study summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of major advisor.

INTERDISCIPLINARY STUDIES (INST)

644. Curriculum Development for Elementary and Secondary Education. (3-0). Credit 3. Strategies for curriculum planning and development; production of scope and sequence curriculum documents, course guide and unit plans. Prerequisite: Graduate classification.

671. Measurement and Evaluation. (2-3). Credit 3. Psychometric methods applied to education, principles of measurement applied to the development and use of teacher-made instruments; use of support technologies to augment instructional management. Prerequisites: IDED 670 and EPSY 439.

672. Educational Research Methods. (3-0). Credit 3. Educational research processes; critical analysis of research reports; survey, observational and experimental research; writing research reports. Prerequisite: IDED 671.

TEACHER EDUCATION (TEED)

649. Instructional Strategies: Principles and Applications. (2-3). Credit 3. Relation of information processing models to theory and practice of planning, delivering, and evaluating instruction in public school settings. Generic competencies required for teacher certification in Texas. Prerequisite: TEED 302.

682. Seminar in . . . (1-0). Credit 1. Knowledge, skills and attitudes in teacher education. May be repeated for credit. Specific topics will be assigned for each semester offered.

683. Field Practicum in Teacher Education. (0-9). Credit 3. Supervised experience in performing professional functions in teacher education settings. Prerequisite: Approval of program coordinator.

684. Professional Internship. (0-27). Credit 9. Supervised experiences in performing professional functions in classroom settings. Prerequisite: Approval of program coordinator.

INTERDISCIPLINARY ENGINEERING
(ITDE)

The interdisciplinary engineering program was originated to accommodate outstanding students who wish to major in fields that cross departmental lines. All the faculty for this program are regular members of other engineering departments. The principal areas of interest under interdisciplinary engineering include mechanics and materials and systems engineering. Other areas of interest which cross disciplinary boundaries may be tailored to suit a student's desires subject to the Office of Graduate Studies regulations and the approval of the student's committee. Students interested in this program should contact the dean of the College of Engineering, Wisenbaker Engineering Research Center.

671. Professional Engineering Ethics and Practice. (2-0). Credit 2. Engineering professional practice; value judgments and ethical considerations related to engineering decisions. Lectures will be invited from professionals practicing in industry and government.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program nor twice in Ph.D. program.

685. Problems. Credit 1 to 4. Research problems of limited scope designed primarily to develop research technique.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of interdisciplinary engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation.

MECHANICS AND MATERIALS
(MEMA)

The mechanics and materials course offerings perform three major functions. First, and most importantly, they are interdisciplinary vehicles for staff and students who study and conduct research in those increasingly important problems requiring a blending of mechanics and materials. Second, they provide the support base for graduate students to pursue studies in the traditional areas of either applied mechanics or materials science. Third, they provide a coordinated set of service courses for the engineering departments. Interested students should contact the head of the Department of Aerospace Engineering.

601. Theory of Elasticity (3-0). Credit 3. Analysis of stress and strain in two and three dimensions, equilibrium and compatibility equations, strain energy methods, torsion of noncircular sections, flexure, axially symmetric problems. Prerequisite: MATH 601 or registration therein.

605. Energy Methods. (3-0). Credit 3. Principle of virtual work, Rayleigh-Ritz method, Galerkin method, minimum potential energy principles, variational principles, Reissner's Variational Theorem. Applications to linear and nonlinear problems in mechanics. Prerequisite: MATH 601 or registration therein.

607. Flow and Fracture of Polymeric Solids. (3-0). Credit 3. Relationship of molecular structure to flow and fracture in polymeric materials; introduction to viscoelastic fracture mechanics; micromechanisms of fracture including crazing; fatigue behavior of polymeric materials.

608. Elasticity of Structural Elements. (3-0). Credit 3. Torsion of cylindrical bodies and thin-walled sections. Beams: bending, shear and shear center, shear flow and shear-lag. Isotropic and anisotropic plate theory: variational formulation, boundary conditions, stability and vibrations of plates. Higher-order plate theories. Thermal stresses. Prerequisites: MEMA 601 or registration therein.

609. Materials Science. (3-0). Credit 3. Structure and properties of solid materials. Prerequisites: Graduate classification; approval of instructor.

610. Applied Polymer Science. (3-0). Credit 3. Macromolecular concepts, molecular weight, tacticity, theory of solutions, rubber elasticity, thermal transitions, rheology, crystallinity, heterogeneous systems and the relation of mechanical and physical characteristics to chemical structure. Applications to polymer blends, thermosetting resins, structural adhesives and composites. For students interested in design and processing of fibrous composites. Prerequisite: Graduate classification.

611. Fundamentals of Engineering Fracture Mechanics. (3-0). Credit 3. Understanding of the failure of structures containing cracks with emphasis on mechanics. Linear elastic fracture mechanics, complex potentials of MUSKHELISHVILI and WESTERGAARD, J-integral, energy release rate, R-curve analysis, crack opening displacement, plane strain fracture toughness testing, fatigue crack propagation, fracture criteria, fracture of composite materials. Prerequisite: AERO 603 or MEMA 601.

612. Wave Propagation in Isotropic and Anisotropic Solids. (3-0). Credit 3. Mathematical and experimental methods of studying stress waves with emphasis on anisotropic solids, e.g., fiber-reinforced composite materials. Waves in an unbounded medium; in a half-space; in rods. Waves in a general anisotropic medium; wave surface, slowness surface, velocity surface, energy velocity and group velocity. Prerequisite: AERO 603 or MEMA 601.

613. Principles of Composite Materials. (3-0). Credit 3. Atomic, molecular, micro/macrostructure with respect to physical and mechanical properties of composite materials. Plastic, metallic and ceramic matrices reinforced with continuous and discontinuous fibers, whiskers and particulates. Mechanical and chemical interactions, failure modes, interface, fabrication techniques and structural design concepts. Prerequisite: Approval of instructor.

618. Designing with Composites. (2-3). Credit 3. Application of composite materials principles to the design of composite structures. Designers from industry will participate directly to provide instruction on current design methods. Design projects assigned to provide practical experience with design procedures. Prerequisites: MEMA 613 and approval of instructor.

620. Processing and Testing of Composite Materials. (2-3). Credit 3. Experiments demonstrating the processing, fabrication and curing, and testing of composite materials including typical matrix resins. Acceptance specifications and tests for raw materials and their influence on the finished product. Variables governing the cure cycle. Destructive and non-destructive tests to determine properties of the finished materials.

632. Structural Stability. (3-0). Credit 3. Buckling of columns, frames, arches, rings, plates, and shells, lateral and torsional buckling of beams, Newmark's method, equilibrium method, Rayleigh-Ritz, variational principles. Galerkin method, Treffetz method, review of current literature. Prerequisites: MATH 308; approval of instructor.

633. Theory of Plates and Shells. (3-0). Credit 3. Small-deflection thin plate theory for plates of various shapes and support conditions, bending of anisotropic plates. Plates under combined lateral loads and in-plane forces. Large deflection thin plate theory, theory of shells, stability of plates and shells. Prerequisite: MATH 601 or registration therein.

636. Theory of Thermal Stresses. (3-0). Credit 3. Heat conduction, thermoelasticity and thermoinelasticity as related to thermal stresses. Prerequisites: MEMA 601; approval of instructor.

640. Theory of Shells. (3-0). Credit 3. Continuation of study of theory of shells introduced in MEMA 633. Limited to study of linear shell theory. Equations formulated using Lame's surface parameters. Membrane analysis, bending analysis and shallow shell theory. Prerequisites: MEMA 633.

641. Plasticity Theory. (3-0). Credit 3. Theory of plastic yield and flow of two and three-dimensional bodies. Classical plasticity theories, unified viscoplastic theories, numerical considerations. Applications and comparisons of theory to experiment. Prerequisite: MATH 601 or registration therein.

646. Introduction to the Finite Element Method. (3-0). Credit 3. Variational formulation for one- and two-dimensional problems. Ritz method, weighted residuals; time-dependent problems. Solution of one- and two-dimensional problems in solid mechanics, fluid flow, diffusion, heat transfer and magnetodynamics utilizing elementary finite element methods. Prerequisite: MATH 308.

647. Theory of Finite Element Analysis. (3-0). Credit 3. Finite elements of a continuum; virtual work principle; plane stress and plane strain; bending of plates; axi-symmetric stress analysis; three-dimensional stress analysis; isoparametric finite elements; recent developments; finite element computer program project; use of several finite element computer programs to solve typical structural problems. Prerequisite: MEMA 467 or equivalent; or approval of instructor.

648. Nonlinear Finite Element Methods in Structural Mechanics. (3-0). Credit 3. Tensor definitions of stress and strain, finite strain, geometric and material nonlinearities; development of nonlinear finite element equations from virtual work; total and updated Lagrangian formulations; solution methods for nonlinear equations; computational considerations; applications using existing computer programs. Prerequisite: MEMA 647 or equivalent.

650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3. Dynamic interaction between fluid and solid systems with applications to space vehicles, nuclear reactors, heat exchangers and structures in general. Hydroelasticity, hydrostatic divergence, flow induced vibrations, instability and compliant surfaces. Prerequisite: MATH 601 and 602 or approval of instructor.

651. Viscoelasticity of Solids and Structures I. (3-0). Credit 3. Linear, viscoelastic mechanical property characterization methods, time-temperature equivalence, multiaxial stress-strain equations. Viscoelastic stress analysis: the correspondence principle, approximate methods of analysis and Laplace transform inversion, special methods. Static and dynamic engineering applications. Nonlinear behavior. Prerequisite: Approval of instructor.

652. Viscoelasticity of Solids and Structures II. (3-0). Credit 3. Thermodynamics of linear and nonlinear viscoelastic materials. Nonlinear constitutive equations based on thermodynamics. Application to civil and aerospace engineering materials and structures. Viscoelastic fracture. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of mechanics and materials. May be repeated for credit. Prerequisite: Approval of instructor.

SYSTEMS ENGINEERING
(SYEN)

Systems engineering is an organized, systematic approach for the application of technology to complex engineering problems. Such applications will invariably involve many considerations and constraints which are not purely technological. The human, sociological, economic, business and political factors are combined with the creative design aspects of engineering. Areas of special career interest can be developed by combining graduate courses in an engineering specialty or business with systems engineering to respond to the growing demand of industry and government for systems oriented graduates. Persons interested in this program should contact the dean of the College of Engineering, Wisenbaker Engineering Research Center.

601. Systems Engineering. (3-0). Credit 3. Processes and patterns of systems engineering: planning, organization and management of programs for developing large, highly complex systems.

620. Preliminary System Design. (2-6). Credit 4. Preliminary design by multidiscipline teams of large engineering projects. Various factors, such as information retrieval and analysis, and marketing and cost-finance analyses are considered along with actual design procedures. Prerequisite: Graduate classification.

622. Computer-Aided Design. (2-6). Credit 4. Detail design of all subsystems from the preliminary designs of SYEN 620 by multidiscipline teams. Computer studies for trade-off decisions and optimization are used extensively to arrive at a finalized design ready for production and/or fabrication. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of systems engineering. May be repeated for credit. Prerequisite: Approval of instructor.

INTERDISCIPLINARY STUDIES
(See Interdisciplinary Education)

DEPARTMENT OF JOURNALISM

J. N. DeBonis, S. J. DeBonis, D. C. Johnson, M. Kern-Foxworth, B. G. Rogers (Head), E. J. Smith*, D. P. Starr, D. E. Tomlinson

*Graduate Advisor

(JOUR)

603. Methods of Specialized Journalism. (3-0). Credit 3. Writing and placement of magazine and journal articles in specialized areas of media content such as agriculture, ecology, science, business, education, natural resources; individual projects directed to student's field of interest.

605. Institutional Public Relations. (3-0). Credit 3. Public relations philosophy and methodology, using the principles of persuasion and attitude change, as adapted to public and private institutions.

685. Problems. Credit 1 to 4 each semester. Research problems related to media; individual work fitted to special needs of students.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an area of journalism. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis.

KINESIOLOGY (PHYSICAL EDUCATION)

(See Health and Physical Education)

DEPARTMENT OF LANDSCAPE ARCHITECTURE

D. B. Austin, E. R. Hoag (Interim Head), R. B. Hull IV, F. Klatt, Jr., H. C. Landphair, L. L. Marshall, M. M. McCarthy, J. L. Motloch*, M. D. Murphy, P. N. Pregill, J. E. Rodiek, N. Volkman, T. M. Woodfin

*Graduate Advisor

The Department of Landscape Architecture offers graduate programs leading to the degrees of master of landscape architecture and doctor of environmental design. The program is designed to develop professional specialized skills in the field and to provide a unique educational experience. Issues dealing with natural resource management, behavioral response, energy and design are emphasized as separate specializations in response to the profession's leadership potentials. Programs are planned to encourage applications from a variety of backgrounds. Emphasis is placed on the development of communication, collaboration and problem solving skills associated with environmental design issues.

(LAND)

601. Landscape Architectural Design Theory. (2-9). Credit 5. Principles and application of landscape architectural design theory, relationships of two and three dimensional space as they relate to the natural and built environment, and illustrative communication. Prerequisite: Graduate classification or approval of instructor.

602. Landscape Architectural Design Application. (2-12). Credit 6. Application of design concepts to site planning and site specific contemporary issues including natural systems, social, political, economic, technological, energy and resource efficiency influences on design. Prerequisite: LAND 601.

603. Principles and Techniques of Land Development. (2-12). Credit 6. Specialized design experiences linked to unique faculty skills and visiting professionals recognized for their outstanding contributions to expanding the boundaries of the profession. Prerequisite: LAND 601.

612. Landscape Architectural Site Development. (2-6). Credit 4. Concepts, theories and techniques of site development; creative land form modification, landscape structures, drainage principles, site circulation and utilization of materials. Prerequisite: LAND 601 or approval of instructor.

613. Urban Design I. (2-4). Credit 3. Cross-listed with ARCH 613.

620. Open Space Development I. (2-9). Credit 5. Solution of complex open space problems. Subjects may be as diversified as large scale land-planning study or the development of a large residential site. Prerequisite: Graduate classification in landscape architecture.

621. Open Space Development II. (2-9). Credit 5. Continuation of LAND 620; production of plans and reports. Prerequisite: LAND 620.

640. Research Methods in Landscape Architecture. (3-0). Credit 3. Research methods including theory, hypothesis formulation, design, data collection, measurement and report writing; equates research activity to landscape architecture and the interaction between people and their physical environment. Prerequisite: LAND 603 or equivalent.

641. Research Implementation in Landscape Architecture. (3-0). Credit 3. Implementing a research activity, including formulation of hypothesis, selection of a research design, collecting and measurement data, discussing progress with other students and writing a research report. Prerequisite: LAND 640, STAT 651 or equivalent.

650. Site Design for Energy Conservation. (2-3). Credit 3. Site design tools for the creation of energy efficient building sites. Prerequisite: Graduate classification.

667. Development Feasibility and Design. (3-9). Credit 6. Prerequisite: Approval of instructor. Cross-listed with ARCH 667 and PLAN 667.

681. Seminar. (1-0). Credit 1 each semester. Analysis and criticism of selected landscape architectural projects. Lectures, reports and discussions. Prerequisite: Graduate classification in landscape architecture.

684. Professional Internship. Credit 1 to 8. Professional practice under approved arrangement with public or private agencies. Off-campus internships are limited to a maximum of eight hours of credit in any semester.

685. Problems. Credit 1 to 6. Individual problems involving application of theory and practice in planning and design of the environment.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of landscape architecture. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for and preparation of dissertation. Prerequisite: Doctoral classification.

693. Professional Study. Credit 1 to 6 each semester. Approved professional study project undertaken as the terminal requirement for the master of landscape architecture degree. Preparation of a record of study summarizing rationale, procedure and results of the completed activity. Prerequisite: Approval of committee chair.

LINGUISTICS

(See English)

DEPARTMENT OF MANAGEMENT

M. A. Abelson**, R. Albanese, J. B. Barney, B. D. Baysinger, K. L. Bettenhausen, L. Bierman, M. B. Castaneda, H. E. Chamberlain, R. L. Daft, G. R. Ferris, J. M. George, R. W. Griffin, D. Hellriegel*(Head), M. A. Hitt, R. E. Hoskisson, D. B. Johnsen, G. R. Jones, G. D. Keim, A. McWilliams, W. H. Mobley, M. W. Pustay, T. F. Reed, G. H. Rice, Jr., L. F. Schoenfeldt, A. W. Smith, T. Turk, D. D. Van Fleet, R. W. Woodman, S. A. Youngblood, A. Zardkoohi

*Doctoral Student Advisor
**Master's Student Advisor

The Department of Management offers graduate studies leading to M.S. and Ph.D. degrees and course work supporting the College of Business Administration's M.B.A. degree.

The M.B.A. degree program consists of 57 credit hours of which 12 credit hours may be taken as electives in the department. Areas of course work include human resources management, organizational behavior and theory, business and public policy, and policy and strategy. The M.S. degree program is designed to give a greater degree of specialization in management. The primary specialization area in the M.S. program is personnel/human resource management. The Ph.D. program emphasizes course work in policy and strategy, organizational behavior and theory, human resource management, and business and public policy.

Additional information, including specific departmental requirements, may be obtained by contacting the department or the office of the dean, College of Business Administration.

(MGMT)

602. Markets and Public Policy. (3-0). Credit 3. Nature of business markets and effects of regulatory constraints. Anti-trust law, securities regulations, consumer protection, human resource issues, environmental controls and regulation effects on business. Classification 6 students may not enroll in this course. Prerequisite: Graduate classification.

610. Business and Public Policy. (3-0). Credit 3. Role of business in contemporary society; large corporations, property rights and externalities. Current criticisms of business and social issues such as pollution, discrimination and natural resource use. Prerequisite: Graduate classification.

620. Human Resources Management. (3-0). Credit 3. Implications for strategic business planning of the design and implementation of human resource functions; human resource systems, formulating and implementing human resource strategy, legal aspects of human resource management, staffing, training and development, compensation, labor relations, and performance appraisal. Classification 6 students may not enroll in this course. Prerequisite: Graduate classification in College of Business Administration or approval of instructor.

622. Staffing. (3-0). Credit 3. Foundations and operating aspects of staffing in various types of organizations. Constraints and legal requirements affecting personnel selection; sources of personnel, job descriptions, job specifications, interviewing, testing, assessment centers and affirmative action requirements. General management, rather than a technician's, point of view. Prerequisite: MGMT 620 or equivalent.

623. Compensation Management. (3-0). Credit 3. Managerial analysis of the role of employee compensation in different types of organizations; job evaluation systems, legal constraints on compensation practices, relation to motivation and satisfaction, wage levels and structures, merit rating, individual and group plans, and fringe benefits. General management, rather than a technician's, point of view. Prerequisite: MGMT 620 or equivalent.

624. Seminar in Human Resources. (3-0). Credit 3. Seminar focuses on current research issues in human resource management. Course is tailored to needs and interests of students. Individual research projects. Prerequisites: MGMT 620 or equivalent and doctoral classification or approval of instructor.

625. Management Training in Industry. (3-0). Credit 3. Content and processes of training and development; economics of training, identification of needs, career development, matching needs with methods, learning process, evaluation of effectiveness and techniques such as in-baskets, simulation, assessment centers and on-the-job training. General management, rather than a technician's, point of view. Prerequisite: MGMT 620 or equivalent.

630. Behavior in Organizations. (3-0). Credit 3. Technologies, theory and research are presented to develop human and conceptual skills needed for individual and managerial effectiveness in organizations. Work motivation, leadership, group and intergroup relations, problem solving styles, conflict and interpersonal communication. Prerequisite: Graduate classification or approval of instructor.

631. Management of Complex Organizations. (3-0). Credit 3. Organizational theory, research and applications important to managerial and organizational effectiveness; motivation and leadership, group effectiveness, decision making, job satisfaction and stress, organizational structure and control, organization-environment relations, conflict, power and politics, and organizational change and development. Classification 6 students may not enroll in this course. Prerequisite: Graduate classification.

632. Organization Design and Theory. (3-0). Credit 3. Alternative forms of organization, organization environment interface, authority responsibility relationships, intergroup power and conflict, decision-making planning and control processes, and applied organizational design. Prerequisite: Graduate classification or approval of instructor.

633. Organization Change and Development. (3-0). Credit 3. Complexity and dynamics of change in organization; assessing different strategies for creating change within an organization; examining different roles of change agents; and identifying strategies for building in the capacity for change in organizations. Prerequisite: MGMT 630 or equivalent.

634. Seminar in Organizational Behavior. (3-0). Credit 3. Seminar in specific behavioral topics; behavioral reinforcement, motivation, group dynamics, leadership, attitude theory and development, task design, interpersonal effectiveness and intergroup relations. Prerequisites: MGMT 630 or MGMT 631 or equivalent and doctoral classification or approval of instructor.

635. Research Topics in Labor Relations. (3-0). Credit 3. Interaction between unions and management, role of government in labor relations and conflict resolution processes. Selected labor or manpower problems of current importance. Prerequisite: Graduate classification.

636. Seminar in Organization Theory. (3-0). Credit 3. Organization theory; research literature; topics include environment, structure and design, bureaucracy, goals, effectiveness, technology, information processing, control, decision making, power, innovation and change, typologies and organizational life cycles. Prerequisites: MGMT 631 or MGMT 632 or equivalent and doctoral classification or approval of instructor.

643. Legal Relationships. (3-0). Credit 3. Basic legal relationships and issues encountered by managers and organizations; American legal system, court system, selected areas of contract law, and law of negotiable instruments. Prerequisite: Graduate classification.

650. Human Relations and Collective Bargaining in Industry. (3-0). Credit 3. Labor management relationship and human relations problems encountered during the three stages of union development, i.e. hostility, transition and cooperation; problems arising from contract administration and encountered at the bargaining table; simulation games. Cross-listed with INEN 603.

652. Arbitration Procedures in Work Practices. (3-0). Credit 3. Status of arbitration in labor relations. Causes of grievances and means of reducing the frequency of a cases going into arbitration. Procedures, techniques and rules of evidence in arbitration. Sensitive areas of collective bargaining. Case studies in arbitration. A simulation game is a course requirement. Cross-listed with INEN 611.

655. Survey of Management. (3-0). Credit 3. Managerial processes, behavioral processes, management information systems and personnel processes. Planning and controlling, organizing, decision-making, staffing and performance evaluation, motivation, groups, leadership, and organizational efficiency and effectiveness. Prerequisite: Graduate classification. Note: This course may not be used for elective credit by a master's candidate in business administration.

656. Due Process of Law and Administrative Procedures. (3-0). Credit 3. Due process in a constitutional context as applied to administrative discretion and the theory and practice of public policy implementation. Administrative procedures are measured against the requirements of due process of law. Cross-listed with POLS 656.

672. Management Information Systems. (3-0). Credit 3. Integrative overview of data processing and management information systems; data flow, systems analysis and design, and information technology and economics. User-needs and managerial requirements stressed more than hardware or software. Prerequisite: MGMT 655 or equivalent.

675. Leadership. (3-0). Credit 3. Review of research on procedures, styles and methods of leadership, supervision, management and administration. All aspects of leader role behavior, both in practice and in research; areas in need of further research. Prerequisite: MGMT 630 or equivalent or approval of instructor.

676. Strategy Formulation. (3-0). Credit 3. Content and process issues in corporate and business level strategy formulation. Prerequisite: Doctoral classification or approval of instructor.

677. Strategy Implementation. (3-0). Credit 3. Concepts, research, and applications regarding content and process issues in corporate strategy implementation. Prerequisite: Doctoral classification or approval of instructor.

678. International Management. (3-0). Credit 3. Problems and issues of international management which arise from economic, political and cultural differences. Lectures, readings and cases used to solve problems faced by expatriate managers as well as issues of home-office management of multinational firms. Prerequisite: MGMT 655 or equivalent.

680. Business Policy. (3-0). Credit 3. Top level decision-making within the business firm. Corporate strategy, policy formulation and implementation. Use of cases, business games, research projects, and, when possible, field cases. Should be taken during last semester of M.B.A. program. Classification 6 students may not enroll in this course. Prerequisite: Graduate classification in College of Business Administration or approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. Critical examination of subject matter presented in current journals, monographs and bulletins in field of management. Prerequisite: Graduate classification.

683. Managerial Planning. (3-0). Credit 3. Long and intermediate range corporate as distinct from operational planning. Corporate-wide strategies and the implementation of strategic plans. Prerequisite: MGMT 680 or registration therein or approval of instructor.

684. Professional Internship. Credit 1-6. Directed internship in an organization to provide students with on-the-job training with professionals in organizational settings appropriate to the students' professional objectives. Prerequisites: Approval of committee chairman and department head.

685. Problems. Credit 1 to 4 each semester. Directed study on selected problems using recent developments in business research methods. Prerequisites: Graduate classification and approval of instructor.

687. Seminar in Research Methodology. (3-0). Credit 3. Philosophy of science; survey of research methodology applicable to the study of organizational phenomena; research strategy and design; measurement and sampling issues; data collection methods. Prerequisites: Doctoral classification or approval of instructor; STAT 651 or equivalent.

688. Doctoral Seminar. (3-0). Credit 3. Advanced study of the academic discipline of management. Theoretical and research developments and controversial issues in the management literature. This course may be taken three times for credit as content varies. Prerequisite: Doctoral classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of management. May be repeated for credit. Prerequisite: Graduate classification.

690. Theory of Research in Management. (3-0). Credit 3. Research practicum; application of research methodology learned in MGMT 687; advanced readings in research methods. Fundamental skills and concepts needed to design and conduct dissertation research. Prerequisites: Doctoral classification or approval of instructor; MGMT 687 or equivalent.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Prerequisite: Graduate classification.

DEPARTMENT OF MARKETING

L. L. Berry, J. J. Burnett, P. S. Busch (Head), A. B. Cocanougher, J. S. Conant, C. L. Costley, C. M. Futrell, S. M. Gillespie, L. G. Gresham, R. T. Hise**, J. H. Leigh, S. W. McDaniel, J. U. McNeal, A. Parasuraman, W. M. Pride*, D. H. Robertson, D. M. Szymanski, P. Varadarajan

*Doctoral Student Advisor
**Master's Student Advisor

The Department of Marketing offers graduate studies leading to M.S. and Ph.D. degrees and course work supporting the College of Business Administration's M.B.A. degree. These programs provide training for students interested in marketing careers.

The M.B.A. degree program consists of 55 credit hours of which 12 credit hours may be taken in the department. The M.S. degree program consists of 36 credit hours and is designed to give a greater degree of specialization in marketing than the M.B.A. program. Areas of specialization include product management, sales force management, marketing research, advertising and physical distribution. The Ph.D. program is designed to prepare students for careers in research and teaching as well as specialized staff positions in public and private organizations.

Additional information, including specific departmental requirements, may be obtained by contacting the department or the office of the dean, College of Business Administration.

(MKTG)

649. Survey of Marketing. (3-0). Credit 3. Marketing concepts and functions from the point of view of the company and the economy. Classification 6 students and non-business graduate students may enroll in designated sections of this course.

650. Analyzing Consumer Behavior. (3-0). Credit 3. Theoretical and empirical material on consumer behavior; personality, social class and perception by consumers. Prerequisite: MKTG 649 or equivalent.

655. Marketing Communications: Personal. (3-0). Credit 3. Personal selling, public relations and customer service. Prerequisites: MKTG 649 or equivalent.

656. Marketing Communications: Non-Personal. (3-0). Credit 3. Communication processes, diffusion of innovation and promotion activities: advertising, packaging, sales promotion and publicity. Prerequisite: MKTG 649 or equivalent.

665. Research for Marketing Decisions. (3-0). Credit 3. Methodology related to problems in marketing decision-making; primary and secondary research methodology and analytical techniques for measuring consumer attitudes, advertising effectiveness, etc. Prerequisites: MKTG 649 or equivalent, and a basic statistics course.

671. Product Innovation. (3-0). Credit 3. Understanding of consumer needs and translating them into new products and services whose design and presentation convey satisfaction of these needs. Prerequisite: MKTG 649 or equivalent.

673. Service and Public Marketing. (3-0). Credit 3. Marketing concepts and strategy as applied to professional and public organizations such as health and public services, and educational, political and charitable organizations.

675. Marketing Management. (3-0). Credit 3. Marketing management as it relates to overall organization goals. Marketing concepts and functions integrated with other organizational functions, tactics and strategies. Classification 6 students may not enroll in this course. Prerequisites: MKTG 649 and graduate classification in business administration.

677. Multinational Marketing Management. (3-0). Credit 3. Theoretical and empirical materials on multinational marketing; nature and justification of international trade, analysis of environments faced by multinational firms and formulation of multinational marketing strategy. Prerequisite: MKTG 649 or equivalent.

680. Seminar in Buyer Behavior. (3-0). Credit 3. Detailed examination of the literature in consumer and industrial buyer behavior with emphasis on conceptual and empirical issues; critical analysis of buyer behavior theory. Prerequisite: MKTG 650 or equivalent.

682. Seminar in Strategic Market Planning. (3-0). Credit 3. Marketing aspects of strategy formulation; the market phenomena that are foundations of strategy, models for strategic business unit and corporate strategy formulation, and organizational implications of the strategic market planning process. Prerequisites: MKTG 649 or equivalent and doctoral classification.

685. Problems. Credit 1 to 4 each semester. Directed study of selected problems using recent developments in business research methods. Prerequisite: Approval of instructor.

688. Doctoral Seminar. (3-0). Credit 3. Historical development of the conceptual framework of marketing theory and practices; analysis of current research and controversial issues in the field. May be repeated for credit three times. For doctoral students only. Prerequisite: M.B.A. or equivalent.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of marketing. May be repeated for credit.

690. Theory of Research in Marketing. (3-0). Credit 3. Design of research in the various subfields of marketing and the evaluation of research results using examples from the current research literature. May be repeated for credit. Prerequisite: Graduate classification in marketing.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

DEPARTMENT OF MATHEMATICS

O. G. Aberth, G. D. Allen, I. Bakelman, K. Ball, D. L. Barrow, G. A. Battle III, G. R. Blakley, H. P. Boas, A. Boggess, J. R. Boone, I. Borosh, J. D. Bryant, G. Chen, C. K. Chui, P. Daripa, R. D. DeBlassie, R. L. Diaz, S. A. Fulling, S. C. Geller, E. Giné, L. F. Guseman, Jr., R. A. Gustafson, D. J. Hartfiel, D. A. Hensley, J. M. Herrmann, A. M. Hobbs, W. B. Johnson, T. R. Kiffe, H. E. Lacey (Head), V. Lakshmibai, D. R. Larson, D. R. Lewis*, C. J. Maxson, J. J. Morgan, F. J. Narcowich, N. W. Naugle, P. Nelson, Jr., W. L. Perry, M. S. Pilant, G. Pisier, J. T. Pitts, H. W. Pu, M. H. Rahe, W. Rundell, V. P. Schielack, Jr., L. L. Schumaker, K. C. Smith, R. R. Smith, M. J. Stecher*, P. F. Stiller, E. Straube, A. H. Stroud, S. D. Taliaferro, L. B. Treybig, T. I. Vogel, J. R. Walton, J. D. Ward, F. B. Weissler, P. B. Yasskin, J. Zhou, J. Zinn

*Graduate Advisor

The Department of Mathematics offers graduate studies leading to the M.S. and Ph.D. degrees in mathematics. Many of the course offerings are also suitable for graduate students pursuing degrees in engineering, science and geosciences.

At the M.S. level, a student can pursue either a thesis or non-thesis degree. For the latter degree, a student can also choose to specialize in applied mathematics.

Satisfactory completion of a departmental qualifying exam is required of all students pursing a Ph.D. In addition, the Ph.D. degree requires a reading knowledge of French, German or Russian.

The Department of Mathematics requires that each student participate in the teaching programs of the department for either two or four semesters as part of the M.S. or Ph.D. degree requirements, respectively.

Detailed information concerning programs and financial assistance may be obtained by writing the Graduate Studies Committee, Department of Mathematics.

(MATH)

601. Higher Mathematics for Engineers and Physicists. (4-0). Credit 4. Methods of linear algebra, vector analysis and complex variables. Prerequisite: MATH 308 or equivalent.

602. Higher Mathematics for Engineers and Physicists. (4-0). Credit 4. Classification of linear partial differential equations of the second order. Fourier series, orthogonal functions, applications to partial differential equations. Special functions, Sturm-Liouville theory, application to boundary value problems. Introduction to Green's functions, finite Fourier integrals. Prerequisites: MATH 601 or 308, 405, and 407.

603. Operator Theory and Partial Differential Equations. (4-0). Credit 4. Theory of operators in partial differential equations and boundary value problems: Laplace and Fourier transforms, adjoint operator, self adjoint and differential operators. Prerequisites: MATH 602 or 311, 312, and 407.

606. Theory of Probability I. (4-0). Credit 4. Measure and integration, convergence concepts, random variables, independence and conditional expectation, laws of large numbers, central limit theorems, applications. Prerequisites: MATH 411 and 447 or approval of instructor.

607. Real Variables I. (4-0). Credit 4. Lebesgue measure and integration theory, differentiation, L^p-spaces, abstract integration, signed measures. Radon-Nikodym theorem, Riesz representation theorem, integration on product spaces. Prerequisite: MATH 410.

608. Real Variables II. (4-0). Credit 4. Banach spaces, theorems of Hahn-Banach and Banach-Steinhaus, the closed graph and open mapping theorems, Hilbert spaces, topological vector spaces and weak topologies. Prerequisite: MATH 607.

609. Numerical Analysis. (3-3). Credit 4. Interpolation, numerical evaluation of definite integrals and solution of ordinary differential equations. Stability and convergence of methods and error estimates. Prerequisite: Knowledge of computer programming (FORTRAN).

610. Numerical Methods in Partial Differential Equations. (3-3). Credit 4. Introduction to finite difference and finite element methods for solving partial differential equations. Stability and convergence of methods and error bounds. Prerequisite: MATH 417 or 609 or their equivalent.

611. Ordinary Differential Equations. (4-0). Credit 4. General methods for first order equations, singular solutions, applications, special methods, linear equations of second order, method of successive approximations, systems of ordinary equations. Prerequisite: MATH 601.

612. Partial Differential Equations. (4-0). Credit 4. General solution of first order equations, second order equations from physics and mechanics. Prerequisite: MATH 611 or equivalent.

613. Graph Theory. (3-0). Credit 3. One or more broad areas of graph theory or network theory, such as planarity, connectivity, Hamiltonian graphs, colorings of graphs, automorphisms of graphs, or network theory. Prerequisite: MATH 431 or equivalent, or approval of instructor.

617. Theory of Functions of a Complex Variable I. (3-0). Credit 3. Holomorphic functions, complex integral theorems, Runge's theorem, residue theorem, Laurent series, conformal mapping, harmonic functions. Prerequisite: MATH 410.

618. Theory of Functions of a Complex Variable II. (3-0). Credit 3. Infinite products, Weierstrass factorization theorem, Mittag-Leffler's theorem, normal families, Riemann mapping theorem, analytic continuation, Picard's theorems and selected topics. Prerequisite: MATH 617.

624. Mathematical General Relativity. (3-0). Credit 3. Differential Geometry: Manifolds, tangent vectors, tensors, metrics, connections and curvature. Special Relativity: 4-vectors, Lorentz transformations and Maxwell's equations for electromagnetism. General Relativity: Einstein's equations for gravity, Schwarzschild's solution, solar system experiments, black holes, Friedmann's solution, cosmology and the big bang. Prerequisites: MATH 311 and PHYS 405 and 416 or equivalent or permission of instructor.

626. Theory of Probability II. (3-0). Credit 3. Topics chosen from weak convergence of probability measures, Brownian motion and invariance principles, Gaussian processes, empirical processes, martingales, Markov processes. Prerequisite: MATH 606 or approval of instructor.

627. Theory of Numbers. (3-0). Credit 3. Quadratic residues; the Legendre, Jacobi and Kronecker symbols; quadratic reciprocity; residue characters; character sums; sums of squares; diophantine equations. Prerequisite: Approval of instructor.

631. Ring Theory. (3-0). Credit 3. Rings and ideals, chain conditions, radicals, simplicity and semisimplicity, modules, homology. Prerequisite: MATH 653 or approval of instructor.

633. Group Theory. (3-0). Credit 3. Abelian groups, Sylow theorems, group actions, Jordan-Holder theorem, solvable and nilpotent groups, additional topics. Prerequisite: MATH 653 or approval of instructor.

636. Topology I. (3-0). Credit 3. Set theory, topological spaces, generalized convergence, compactness, metrization, connectedness, uniform spaces, function spaces. Prerequisite: MATH 436 or approval of instructor.

637. Topology II. (3-0). Credit 3. Continuation of MATH 636. Prerequisite: MATH 636 or approval of instructor.

638. Calculus of Variations. (3-0). Credit 3. Theory and applications of methods of calculus of variations as applied to optimal problems. Prerequisite: MATH 601.

639. Iterative Techniques. (3-3). Credit 4. Numerical methods for solving linear and nonlinear equations and systems of equations; eigenvalue problems. Prerequisite: Elementary linear algebra and knowledge of computer programming (FORTRAN).

640. Analysis for Applications I. (4-0). Credit 4. Review of linear algebra; spectral theory in inner product spaces; decomposition theorems; duality theory and multilinear algebra; tensor products; applications. May be taken concurrently with MATH 641. Prerequisite: MATH 304 or equivalent.

641. Analysis for Applications II. (4-0). Credit 4. Review of preliminary concepts; cardinality; topological results in R; metric topologies; function and sequence spaces; contraction mappings and generalizations; applications of fixed point theory; Lebesgue measure and integration.

642. Analysis for Applications III. (4-0). Credit 4. Theory of normed linear spaces; inner product spaces; duality and representations; spectral theory in normed spaces; self-adjoint operators; application to integral equations.

643. Algebraic Topology I. (3-0). Credit 3. Fundamental ideas of algebraic topology, homotopy and fundamental group, covering spaces, polyhedra. Prerequisite: MATH 436 or approval of instructor.

644. Algebraic Topology II. (3-0). Credit 3. Homology and cohomology theory. Prerequisite: MATH 643.

651. Optimization I. (3-0). Credit 3. Fundamentals of mathematical analysis underlying theory of constrained optimizations for a finite number of variables, necessary and sufficient conditions for constrained extrema of equality constraint problems, sufficient conditions for fulfillment of constraint qualification, computational methods for concave programming problems and applications. Prerequisite: MATH 410 or approval of instructor.

652. Optimization II. (3-0). Credit 3. Necessary conditions of calculus of variations, elementary theory of games, formulation of basic control problem, Hestenes' necessary conditions for optimal control, transformations, methods of computation and applications. Prerequisite: MATH 651.

653. Algebra I. (3-0). Credit 3. Survey of groups, rings, ideals. Prerequisite: MATH 415 or approval of instructor.

654. Algebra II. (3-0). Credit 3. Survey of modules, field extensions, Galois theory. Prerequisite: MATH 653 or approval of instructor.

655. Functional Analysis I. (3-0). Credit 3. Normed linear spaces, duality theory, reflexivity, operator theory. Banach algebras, spectral theory, representation theory. Prerequisite: MATH 608.

656. Functional Analysis II. (3-0). Credit 3. Topological linear spaces, locally convex spaces, duality in locally convex spaces, ordered topological vector spaces, distribution theory, applications to analysis. Prerequisite: MATH 655.

657. Spline Approximation I. (3-0). Credit 3. Review of fundamental concepts of approximation, polynomials and other tools; basic univariate spline theory including bases, computational algorithms and approximation power; applications to interpolation, discrete approximation and data fitting. Prerequisites: MATH 304 and 417 or equivalents.

658. Spline Approximation II. (3-0). Credit 3. Tensor-product methods using polynomials and B-splines; computation and application of tensor methods to interpolation and approximation; triangle-based methods; dimension problems, local bases and approximation power; application to scattered data fitting, computer-aided design and finite element analysis. Prerequisite: MATH 657 or equivalent.

661. Calculus of Finite Differences. (3-0). Credit 3. Introduction to difference equations, finite element analysis and splines. Prerequisite: Approval of instructor.

662. Seminar in Algebra. (3-0). Credit 3. Problems, methods and recent developments in algebra. This course may be taken three times for credit as content varies. Prerequisite: Approval of instructor.

663. Seminar in Analysis. (3-0). Credit 3. Problems, methods and recent developments in analysis. This course may be taken three times for credit as content varies. Prerequisite: Approval of instructor.

664. Seminar in Applied Mathematics. (3-0). Credit 3. Problems, methods and recent developments in applied mathematics. This course may be taken three times for credit as content varies. Prerequisite: Approval of instructor.

665. Seminar in Topology. (3-0). Credit 3. Problems, methods and recent developments in topology. This course may be taken three times for credit as content varies. Prerequisite: Approval of instructor.

667. Approximation Theory. (3-0). Credit 3. Existence, uniqueness and characterization of best approximations; polynomial and rational approximants; inequalities; order of approximation; interpolation, algorithms; n-widths; saturation theorems; approximation in Hankel norm. Prerequisites: MATH 407 and 409.

670. Applied Mathematics I. (3-0). Credit 3. Mathematical tools of applied mathematics; Fredholm alternative; integral operators; Green's functions; unbounded operators; Stone's theorem; distributions; convolutions; Fourier transforms; applications. Prerequisite: MATH 642 or equivalent.

671. Applied Mathematics II. (3-0). Credit 3. Mathematical tools of applied mathematics; Sobolev spaces; convexity; variational inequalities; variational methods for partial differential equations; maximum principles; elements of nonlinear analysis; compact operators; fixed point theorems; applications. Prerequisite: MATH 670 or equivalent.

675. Mathematical Structure of the Real Line. (3-0). Credit 3. Topologies for the real line and the plane, compactness, connectedness, continuity, algebraic structures, topological group, the real numbers as topological field; designed primarily for teachers. Prerequisite: MATH 375, 376 or approval of instructor.

685. Problems. Credit 1 to 4 each semester. Offered to enable students to undertake and complete, with credit, limited investigations not within their thesis research and not covered by any other courses in the curriculum. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of mathematics. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation.

695. Frontiers in Mathematical Research. (3-0). Credit 3. This course is designed to acquaint the graduate student with the present status of investigative work in a variety of mathematical fields. Content will depend on the availability of visiting lecturers who will be selected because of distinguished international recognition in their field of research. May be taken two times for credit. Prerequisite: Graduate classification.

697. Seminar in the Teaching of Calculus. (1-0). Credit 1. Theorems, applications and concepts of calculus, methods and mechanics of teaching calculus and college mathematics, discussion of computer assisted instruction. May not be repeated for credit. Prerequisite: Teaching assistant in the Mathematics Department.

DEPARTMENT OF MECHANICAL ENGINEERING

R. M. Alexander*, N. K. Anand, T. L. Anderson, K. Annamalai, E. A. Baskharone, W. L. Bradley, D. E. Bray, C. P. Burger, J. A. Caton, D. W. Childs, R. Chona, D. E. Claridge, M. A. Colaluca, L. R. Cornwell, M. R. Driels, J. J. Engblom, L. J. Everett, L. S. Fletcher, A. J. Giacomin, R. E. Goforth, R. B. Griffin, S. W. Gyeszly, J.-C. Han, K. T. Hartwig, W. M. Heffington, H. A. Hogan, R. E. Holmes, C. L. Hough, Jr., D. G. Jansson, S. Jayasuriya, C. F. Kettleborough, H. D. Kihm, T. J. Kozik, T. R. Lalk, W. R. Laster, S. C. Lau, A. Letton, J. E. Mayer, Jr., M. McDermott, A. R. McFarland, B. W. Mooring, G. L. Morrison, W. M. Moses, C. C. Nelson, J. L. Nikolajsen, S. T. Noah, O. O. Ochoa, D. L. O'Neal, R. H. Page, A. B. Palazzolo, J. V. Perry, Jr., G. P. Peterson, M. J. Rabins (Head), J. G. Raczkowski, R. Redfield, D. L. Rhode, H. H. Richardson, T. Schobeiri, J. Seyed-Yagoobi, S. Somasundaram, M. N. Srinivasan, H. R. Thornton, W. D. Turner, J. M. Vance, J. A. Weese, A. Wolfenden

*Graduate Advisor

The graduate program in mechanical engineering is designed to offer a choice in curriculum depending upon career objectives. Students interested in research and/or teaching may follow the master of science and doctor of philosophy route. Those

interested in practicing engineering at an advanced level in government or industry may pursue the master of engineering. This degree is offered in those areas of mechanical engineering which have a prescribed plan of study on file in the department. The department also offers courses and faculty supervision for students pursuing the doctor of engineering degree. The following courses are provided to enable each student to tailor an individual program consistent with a degree choice.

Each mechanical engineering graduate course is designed to provide a clear presentation of the underlying principles and theories essential to an understanding of the subject. Analytical and experimental techniques are described when required to apply the subject material to modern problems facing today's engineers. In many cases, the course material supplements active research in mechanical engineering areas currently being done at Texas A&M and other prominent research centers around the world. Active research facilities are available for mechanical testing, fracture testing, metallurgical studies, experimental stress analysis, vibrations and rotating machinery, turbomachinery, fluid dynamics, power generation, combustion, *in situ* lignite gasification, heat transfer, energy management, corrosion, solar energy and wind tunnel studies. In addition, new research programs have begun in manufacturing processes, nondestructive testing, computer-aided design, manufacturing, plastics engineering, artificial intelligence and robotics.

There is no foreign language requirement for the Ph.D. program in mechanical engineering. Each student, with the advice of his or her chosen Advisory Committee, selects courses to develop a strength in an area of specialization composed of the following mechanical engineering subgroups: thermal science, fluid mechanics, solid mechanics, materials science and mechanical systems.

(MEEN)

601. Advanced Machine Design. (3-0). Credit 3. Advanced problems in design; bearings, brakes and clutches, gears, piping systems, shafts, springs, stress analysis and other related topics. Prerequisite: MEEN 446 or equivalent.

603. Power Plants. (3-0). Credit 3. Engineering problems associated with the production of electrical power; economic availability of fuels, government regulations, combustion and thermodynamic cycle analysis from both a first law and second law point of view. Fossil fuel and nuclear plants.

604. Theories of Engineering Experimentation. (2-3). Credit 3. Experiment planning skills, evaluate errors and their cumulative effects, check and cross check developing data, and lay out these data in an ordered and revealing manner. Experimental error and uncertainty analysis, experiment planning, statistical and graphical data analysis, and instrument response. Prerequisite: Graduate classification.

605. Engineering Analysis. (3-0). Credit 3. Emphasis on current simulation methods of solving problems common to mechanical design; formulation of finite element models; static solutions considering distributed and thermal loads. Eigenvalue techniques in stability and dynamic analysis; direct and modal formulation of dynamical equations; treatment of constrained and partially constrained systems; sensitivity analysis and probabilistic structures. Design problems using commercially available CAD software.

606. Design of Models. (3-0). Credit 3. Analytical methods and analogue techniques used to design accurate system models. Classical methods of similitude and model design. Methods of performance from distorted models and dissimilar models. Prerequisites: A course in differential equations; graduate classification.

610. Elastic Wave Propagation. (3-0). Credit 3. Wave propagation in solids; studies of material properties, reflection and refraction from discontinuities, propagation in layered media, effects of anisotropy. Prerequisite: Graduate classification.

611. Ultrasonic Techniques in Material Studies. (3-0). Credit 3. Ultransonic techniques used for material property studies and flaw characterization; computer oriented signal analysis and interpretation. Prerequisite: Approval of instructor.

612. Mechanics of Robot Manipulators. (3-0). Credit 3. Kinematics, dynamics and control of industrial robot manipulators. Prerequisites: MEEN 335, 411, 434 or approval of instructor.

613. Engineering Dynamics. (3-0). Credit 3. Three dimensional study of dynamics of particles and rigid bodies and application to engineering problems. Introduction to Lagrange equations of motion and Hamilton's principle. Prerequisites: MATH 308, MEEN 213.

615. Advanced Engineering Thermodynamics. (3-0). Credit 3. Theories of thermodynamics and their application to the more involved problems in engineering practice and design. Equilibrium, Gibbs' function, nonideal gases and various equations of state. Second law analysis and statistical theory. Prerequisite: MEEN 328 or equivalent.

617. Mechanical Vibrations. (3-0). Credit 3. Linear theory of vibrations of finite number of degree of freedom systems via Lagrange equations. Engineering applications. Prerequisites: MATH 308, MEEN 213.

618. Experimental Methods in Mechanical Vibrations. (3-0). Credit 3. Sensors, instruments, measurement techniques, data acquisition methods; data reduction methods for vibration measurement and modal analysis; applications including turbomachinery blades, vanes, gears, bearings and rotors; structures such as beams, frames and machine foundations. Prerequisite: MEEN 459 or 617.

621. Fluid Mechanics. (3-0). Credit 3. Dynamics of two-dimensional incompressible and compressible fluids. Viscous flow in laminar and turbulent layers, the Navier-Stokes equations, boundary layer theory and applications to turbomachinery design.

622. Applications of Fluid Mechanics. (3-0). Credit 3. Applications of the principles of fluid mechanics to specific problems of interest to the mechanical engineer. Analyses of fluid networks and devices. Flow measurement techniques and control methods for unsteady flows. Prerequisite: MEEN 344.

623. Applications of Engineering Fracture Mechanics. (3-0). Credit 3. Introduction to elastic and elastic-plastic fracture mechanics including stress intensity, J-integral, crack tip opening displacement; emphasis on experimental aspects of fracture mechanics and design applications using LEFM, CTOD (BP6493) and J-integral (R-6); micromechanics of fracture in metals and alloys, including relationship of microstructure to fracture toughness; fatigue, environmental cracking. Prerequisite: MEEN 340 or approval of instructor.

624. Two-Phase Flow and Heat Transfer. (3-0). Credit 3. Current status of two-phase flow and heat transfer for application to design. Basic one dimensional treatment of two-phase flows and the current state of the art in liquid-vapor phase change heat transfer. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer.

626. Lubrication Theory. (3-0). Credit 3. Development of Reynolds equation from Navier-Stokes equation for study of hydrodynamic lubrication theory as basis for bearing design. Application to simple thrust and journal bearings and pads of various geometries. Hydrostatic lubrication, floating ring bearing, compressible fluid (gas) lubrication, grease lubrication, dynamically loaded bearings, half speed whirl and stability. Prerequisites: MATH 308; MEEN 344 or equivalent.

627. Heat Transfer-Conduction. (3-0). Credit 3. Mathematical theory of steady-state and transient heat conduction. Solution of the governing differential equations by analytical and numerical methods; applications to various geometric configurations. Prerequisites: CPSC 458 or equivalent; MATH 601 or registration therein; MEEN 461.

628. Heat Transfer-Convection. (3-0). Credit 3. Mathematical theory of convection energy transport. Applications to the design of heat-transfer apparatus. Prerequisites: MATH 601 or registration therein; MEEN 461.

629. Heat Transfer-Radiation. (3-0). Credit 3. Mathematical theory of thermal radiation with design applications. Ideal and nonideal radiating surfaces, heat transfer in enclosures, solar radiation. Analytical, numerical and analogical methods stressed in problem solving. Prerequisites: MATH 601 or registration therein; MEEN 461.

630. Intermediate Heat Transfer. (3-0). Credit 3. Application of basic laws to the analysis of heat and mass transfer. Exact and approximate solutions to conduction, convection and radiation problems. Current status of single and two-phase heat transfer for application to design. Prerequisites: Undergraduate courses in fluid mechanics and heat transfer.

632. Field Computations in Engineering. (3-0). Credit 3. Application of numerical methods to design problems associated with flow of fluids, heat and stress. Application to physical design problems. Prerequisites: MATH 601; graduate classification.

633. Combustion Science and Engineering. (3-0). Credit 3. Fuels and combustion, mass transfer, transport properties, conservation laws, droplet, particle and slurry combustion, sprays, combustion in flow systems flammability, ignition, extinction, flame stability, laminar and detonation waves, premixed flames, application to burners—residential, utility and transportation, fluidized bed combustors, and fire and flame spread of modern building materials. Prerequisites: MEEN 328, 344, 461, or equivalent.

639. Dynamics of Rotating Machinery. (3-0). Credit 3. Dynamic stability, critical speeds and unbalanced response of rotor-bearing systems. Special problems encountered in modern applications operating through and above critical speeds. Prerequisite: MEEN 459 or 613.

640. Dynamic Systems Modeling and Simulation. (3-0). Credit 3. Unified physical systems modeling of uni- and multi-domain energetic systems using the Bond Graph approach; equation generation, system analysis and computer simulation. Prerequisite: MEEN 335.

645. Advanced Gas Dynamics. (3-0). Credit 3. Continuous and discontinuous unsteady one-dimensional flow, hydraulic analogy for steady and unsteady gas dynamics, hypersonic viscous flows, hypersonic gas dynamics of slender and blunt bodies, and radiation gas dynamics encountered in design. Prerequisites: MATH 601 or approval of instructor; MEEN 472.

646. Aerothermodynamics of Turbomachines. (3-0). Credit 3. Fluid mechanics and thermodynamics as applied to the design of rotating systems. Development of turbomachinery equations. Detailed aerodynamic design of compressors and turbines. Prerequisites: MATH 601 or approval of instructor; MEEN 414, 472.

647. Vibrations of Plates and Shells. (3-0). Credit 3. Geometrics of the plate and the shell; concepts, formulation and methods of solution associated with vibrational problems concerning plates and shells. Anisotropic media, variable thickness and implane forces. Prerequisite: MEEN 617 or equivalent.

649. Nonlinear Vibrations. (3-0). Credit 3. Exact and approximate solutions to nonlinear differential equations in mechanical vibrations; application of classical methods in nonlinear analysis such as the Method of Perturbations and Variation of Parameters. Virtual Work Technique and the Modified Galerkin Method. Applications to selected nonlinear problems. Prerequisites: A course in differential equations; graduate classification.

653. Dynamics and Control of Robot Manipulators. (3-0). Credit 3. Brief review of Newton-Euler mechanics for moving frames leading to computationally efficient recursive formulation for multi-body systems; similar development for Lagrangian approach followed by a comparison of the methods; issues in control including contemporary control strategy, parameter uncertainty, robustness, computed torque linearization methods and adaptive control. Prerequisite: MEEN 612 or approval of instructor.

654. Boundary Elements. (3-0). Credit 3. Boundary element analysis of 2 and 3D potential, elastostatic and elastodynamic problems; Green's and Somigliana's boundary formulas; weighted residual methods, Green's function, isoparametric boundary elements, recent developments and computer programming techniques. Prerequisite: MEMA 646 or 647, or approval of instructor.

655. Metal Forming. (3-0). Credit 3. Theory of plastic deformation of metals; slab analysis, slip-line theory and upper bound analysis to solve practical metal forming problems such as forging, extrusion, rolling, stamping; strain-rate and temperature effect including super plasticity; computer solutions emphasized. Prerequisite: MEEN 465 or equivalent.

660. Advanced Topics in Corrosion. (3-0). Credit 3. Advanced treatment on stress corrosion cracking, hydrogen embrittlement, corrosion fatigue and erosion/corrosion of materials; basic electrochemical nature of these reactions; physical metallurgy principles and appropriate experiment techniques. Prerequisite: MEEN 460, CHEN 428, 619, or equivalent or approval of instructor.

661. Energy Systems. (3-0). Credit 3. Problems of meeting the growing energy demand; technical, economic and political considerations engineers balance in selecting an energy source; advantages and disadvantages of each energy source. Prerequisites: B.S. in engineering; MEEN 327 or equivalent.

662. Energy Management in Industry. (3-0). Credit 3. Energy systems and components frequently encountered in industrial environments. Application of basic principles of thermodynamics, heat transfer, fluid mechanics and electrical machinery to the analysis and design of industrial system components and systems. Improved energy utilization. Prerequisites: MEEN 328 and 461 or approval of instructor.

664. Energy Management in Commercial Buildings. (3-0). Credit 3. Basic heating, ventilating and air conditioning system design/selection criteria for air conditioning and heat system and design/selection of central plant components and equipment. Prerequisite: MEEN 328 and 461 or approval of instructor.

665. Application of Energy Management. (3-0). Credit 3. Continuation of MEEN 662 and 664. Case studies by students of energy conservation opportunities using energy audits and building load computer simulation. Prerequisites: MEEN 662 and 664 or approval of instructor.

666. Computer Control of Manufacturing Systems. (3-0). Credit 3. Fundamentals in Numerical Control/Computerized Numerical Control machine tools: motion control, interpolation techniques and programming; concepts of industrial robots; control, programming and applications in adaptive control, group technology, programmable controllers. Prerequisites: MEEN 355 or 411, and CPSC 202.

667. Mechatronics. (3-0). Credit 3. Mechatronics; logic circuits in mechanical systems; electrical-mechanical interfacing; analysis and applications of computerized machinery. Prerequisite: Graduate classification in engineering.

670. Damping in Materials. (3-0). Credit 3. Mechanisms of mechanical damping (or internal friction) in metals, alloys and polymers; mechanical models, and relaxations due to defects, dislocations, grain boundaries, phase changes and magnetoelasticity; damping measurements on several materials in laboratory. Prerequisite: MEEN 340 or equivalent.

671. Metallurgical Failure Analysis. (3-0). Credit 3. Metallurgical failure analysis methodology; empirical tools including fractography, metallography, tensile and hardness testing; causes of service failures including manufacturing defects, material defects, improper design, environmental effects, overloads; steps in conducting a failure analysis in design and manufacturing; case studies in failure analysis. Prerequisite: MEEN 340 or equivalent.

672. Creep and High Temperature Corrosion. (3-0). Credit 3. Materials used for high temperature applications; the physical metallurgy of metals and ceramics with emphasis on the relationship between microstructure and properties; topics will be creep, hot corrosion, oxidation, experimental methods. Prerequisite: MEEN 340 or approval of instructor.

673. Gas Dynamics of Separation and Reattachment. (3-0). Credit 3. Irreversible thermodynamics of real fluids in viscous-inviscid interactions; flow field and heat transfer analyses of separation and reattachment for incompressible and compressible flows. Prerequisite: MEEN 622 or 645 or approval of instructor.

681. Seminar. (0-1). Credit 1. Current research in a wide range of fields described by guest lecturers who are prominent in their fields. Discussion period at the end of each lecture will permit the students to learn more about the lecturer and his/her work. Prerequisite: Graduate classification in mechanical engineering.

684. Professional Internship. Credit 1 or more each semester. Supervised work in an area closely related to the specialized field of study undertaken by a master of engineering candidate. Prerequisite: Admission to a specialized master of engineering program in mechanical engineering.

685. Problems. Credit 1 to 4 each semester. Content will be adapted to interest and needs of group enrolled.

689. Special Topics in . . . Credit 1 to 4. The special topic selected each time will depend upon the interest of the student group involved. A poll of all concerned will be conducted during each semester preceding the one in which the course will be presented. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Methods and practice in mechanical engineering research for thesis or dissertation.

The following courses are described in the section entitled Mechanics and Materials and are prefixed with the letters MEMA They are part of the curriculum in mechanical engineering.

601. Theory of Elasticity. (3-0). Credit 3.

605. Energy Methods. (3-0). Credit 3.

607. Flow and Fracture of Solids. (3-0). Credit 3.

608. Elasticity of Structural Elements. (3-0). Credit 3.

609. Materials Science. (3-0). Credit 3.

610. Applied Polymer Science. (3-0). Credit 3.

611. Fundamentals of Engineering Fracture Mechanics. (3-0). Credit 3.

613. Principles of Composite Materials. (3-0). Credit 3.

618. Designing with Composites. (2-3). Credit 3.

620. Processing and Testing of Composite Materials. (2-3). Credit 3.

632. Structural Stability. (3-0). Credit 3.

633. Theory of Plates and Shells. (3-0). Credit 3.

636. Theory of Thermal Stresses. (3-0). Credit 3.

640. Theory of Shells. (3-0). Credit 3.
641. Plasticity Theory. (3-0). Credit 3.
646. Introduction to the Finite Element Method. (3-0). Credit 3.
647. Theory of Finite Element Analysis. (3-0). Credit 3.
648. Nonlinear Finite Element Methods in Structural Mechanics. (3-0). Credit 3.
650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3.
651. Viscoelasticity of Solids and Structures I. (3-0). Credit 3.
652. Viscoelasticity of Solids and Structures II. (3-0). Credit 3.

MECHANICS AND MATERIALS
(See Interdisciplinary Engineering)

COLLEGE OF MEDICINE

A graduate program in medical sciences, leading to the degrees master of science and doctor of philosophy, has been recently instituted in the College of Medicine.

A special feature of the program is an emphasis on broad based instruction in medical sciences, inasmuch as the faculty in the College of Medicine believes that the quality of teaching and research in medical sciences is highest in those programs that provide a strong, conceptual framework derived from a firm foundation of formal course work. Students who master this background in medical sciences are properly prepared to undertake programs of high quality research.

Traditionally, master's and doctoral degrees in basic medical sciences have been awarded in clearly subdivided disciplines such as anatomy, biochemistry, physiology, microbiology and pharmacology. However, the boundaries separating these disciplines have become less distinct because of the development of integrated programs in medical education and because of the necessity for interdisciplinary collaboration in biomedical research. While the requirements of medical schools for faculty and for medical researchers increasingly include a broad base in medical sciences, most of the graduate programs in this area continue to emphasize education along fairly narrow, traditional departmental lines. The graduate program in medical sciences at Texas A&M University is designed specifically to remedy this deficiency by bridging traditional disciplinary lines through both course work and research.

Applicants normally will be admitted to the program only to pursue the Ph.D. degree, but physicians in residency training who desire to study for a master of science degree in basic science may be permitted to do so. Master of science degree candidates must complete a minimum of 32 semester hours credit. The College of Medicine also offers a combined M.D./Ph.D. program by allowing selected medical students to enroll in graduate programs simultaneously with studies toward the M.D. degree. In addition, highly motivated and well prepared physicians in residency training may enroll in the graduate program (coincident with their residency training) in order to pursue the Ph.D. degree.

The Ph.D. program will require a minimum of 96 semester hours, at least 60 hours of which will be taken in formal course work. To ensure the multidisciplinary nature of the program, each student will be required to complete a minimum of 28 semester hours in a core program of courses from at least four discipline areas. To emphasize the interdisciplinary character of the program further, each student will be required to take, for three to five credit hours, a methodology course in a basic science discipline different from his or her specialized discipline. This collateral experimental problem, selected by consultation between the student and his or her committee, may complement the thesis problem or be supplemental to it.

Upon application to the program each student will declare an area of research interest from the basic disciplines of anatomy, biochemistry, physiology, microbiology and immunology, or pharmacology and toxicology. The graduate advisor for that discipline area will design, with the student, a course of study.

Selected courses within the College of Medicine may be taken for graduate credit by majors in other colleges. Only students admitted to, and in good standing in, the Office of Graduate Studies of Texas A&M University will be considered for admission to these courses. The number of graduate students who can enroll in each course is limited by the availability of facilities and by the requirements of the students in the professional curriculum in medicine. Each graduate student seeking admission to these courses must have the approval of his or her faculty advisor, the head of the department in the College of Medicine administering the course and the Dean of Medicine. Interested students are encouraged to consult the Office of Graduate Studies, College of Medicine, or the *Texas A&M University Class Schedule* for current offerings.

Applicants should also be advised that the College of Medicine courses are presented by terms rather than by semesters; thus, advanced planning on the part of the graduate student is required if he or she is simultaneously taking other courses within the University.

A limit of 12 hours of College of Medicine courses may be applied to a master's level degree program for majors in other colleges.

The specific courses approved for graduate credit are:

COLLEGE OF MEDICINE
(MSCI-Medical Sciences)

601. Principles of Basic Medical Sciences I. (5-0). Credit 5. Molecular basis of cellular functions in human body: technologies for probing cellular functions and structures; plasma membrane, internal membranes, and intracellular organelles; gene function; cell metabolism; cell motility and cytoskeleton. Prerequisites: BIOL 413; BICH 303 or equivalent.

602. Principles of Basic Medical Sciences II. (5-0). Credit 5. Continuation of MSCI 601. Molecular basis of cellular functions in human body: Intracellular and Intercellular signaling; cell growth, division and differentiation; molecular basis of immunology, neurosciences and cardiovascular sciences. Prerequisite: MSCI 601 or equivalent.

681. Seminar. (1-0). Credit 1. Research presentations in areas of current interest in the medical sciences. Prerequisite: Graduate classification in appropriate field.

685. Problems. Credit 1 to 6 each semester. Limited investigation in fields other than those chosen for thesis or dissertation. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of medical sciences. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Medical Sciences Research. (2-0). Credit 2. Design of research experiments in various fields of medical sciences; evaluation of end results with the aid of examples taken from current scientific literature. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation. Prerequisite: Approval of supervisory professor in chosen field.

695. Frontiers in Medical Sciences Research. (2-0). Credit 2. Present status of research in a variety of significant medical sciences fields. Content will depend on the availability of visiting lecturers who will be selected because of distinguished international recognition in their field of research. May be repeated for credit. Prerequisite: Graduate classification in appropriate fields.

Department of Anatomy (MANA)

601. Advanced Neuroscience. (1-2). Credit 2. Details of mammalian nervous system including man; focus on organization of functional neural systems and their integrative action; dissection of human brains; use of original research papers. Prerequisites: MANA 922 and approval of instructor.

602. Histochemistry. (1-2). Credit 2. Basic histochemistry demonstrating tissue components and morphology; precise identification, localization of tissue components. Prerequisites: MANA 911 and approval of instructor.

603. Special Regional Human Dissections. Credit 1 to 3 each semester. Dissection of special region with more detail than in MANA 901; histological, neural and gross anatomical material utilized. Prerequisites: MANA 901 and approval of instructor.

607. Methods of Behavioral Brain Research. (0-3). Credit 1. Advanced laboratory course in brain and behavior research; direct supervision in brain surgery techniques, electrical stimulation, recording, behavioral training; brain imaging using autoradiography; computerized data collection and analysis. Uses laboratory animals. Prerequisites: MANA 922 and approval of instructor.

608. Methods in Neurohistology. (1-2). Credit 2. Instruction in anesthetization, perfusion of animals; removal of neural tissues; histological processing, staining of tissues. Prerequisites: MANA 911 and approval of instructor.

609. Neurochemistry. (2-0). Credit 2. Emphasis on mammalian neurotransmitter systems. Prerequisites: MANA 922 or equivalent and approval of instructor.

640. Biomineralization in Animals. (2-0). Credit 2. Factors involved in the process of biomineralization; role of nutrients, physiological processes and environment in normal and abnormal biomineralization. Prerequisite: Approval of instructor.

901. Gross Anatomy. Credit 8. Relationships of structures of the human body during its development and in adult form as revealed through dissection; functional significance. Prerequisite: Admission to the medical curriculum or approval of department head.

911. Microscopic Anatomy. Credit 5. Morphologic detail of human cells, tissues and organs as demonstrated by light and electron microscopic techniques; function of structural components. Prerequisite: Admission to medical curriculum or approval of department head.

922. Neuroanatomy. Credit 5. Neural substrates for total regulation of somatic and visceral bodily function and mechanisms underlying the integrated action of the central nervous system; neurologic significance. Prerequisite: Admission to medical curriculum or approval of department head.

985. Problems. Credit 1 or more. Special problem areas within framework of human gross, microscopic, neuro- or developmental anatomy. Prerequisite: Approval of department head.

991. Research. Credit 1 or more. Original investigation of selected areas in anatomy. Prerequisite: Approval of department head.

Department of Medical Biochemistry and Medical Genetics (MBCH)

601. Medical Molecular Biology. (3-0). Credit 3. Application of recombinant DNA techniques to the diagnosis and study of human genetic and transmissable diseases; molecular biology as applied to the study of human pathogens and to the function of the human immune system. Prerequisite: MBCH 913 or equivalent or approval of the instructor.

604. Developmental and Cellular Biochemistry. (3-0). Credit 3. Basic structure and function of eukaryotic cells with special emphasis on biochemical communication between internal cell compartments and between cells and their environment. Molecular basis of differentiation. Oncogenes and disorders of differentiation in humans. Prerequisites: MBCH 911/912 or approval of the instructor.

911. Medical Biochemistry I: Macromolecules, Molecular Biology and Molecular Genetics. Credit 4. Properties and metabolism of proteins, DNA, and RNA. Recombinant DNA technology and applications to human medicine. Introduction to the metabolic basis of inherited disease. Prerequisite: Admission to the medical curriculum or approval of department head.

912. Medical Biochemistry II: Intermediary Metabolism. Credit 4. Metabolic basis of inherited disease continued. Prerequisite: MBCH 911 or approval of department head.

913. Medical Genetics. Credit 2. Fundamentals of medical genetics, including diseases resulting from inborn errors of metabolism that affect individual enzymes; chromosomal abnormalities, including aneuploidy and translocations; human gene mapping; and applications of recombinant DNA technology to problems of medical genetics. Prerequisite: MBCH 911.

985. Problems. Credit 1 or more. Directed individual study of advanced topics in medical biochemistry. Prerequisite: Approval of department head.

991. Research. Credit 1 or more. Original laboratory investigation in specific areas of medical biochemistry. Prerequisite: Approval of department head.

Department of Medical Microbiology and Immunology (MMIM)

602. Immunoregulation. (3-0). Credit 3. In-depth exploration of the genetic, cellular and molecular mechanisms by which humoral and cellular immune responses are regulated. Regulatory T cell circuits, molecules (interleukins, lymphokines), isotypic and idiotypic regulation, hormonal effects, immunoregulatory defects, experimental manipulation of immunoregulatory networks. Prerequisite: VTMI 649 or BIOL 610 or approval of instructor.

923. Infection and Immunity. (3-2). Credit 4. Prokaryotes, eukaryotes and viruses with respect to structure, physiology, nutrition, genetics, ecology and pathogenicity for the human host. Biological and biochemical mechanisms of the immune response to infectious agents. Prerequisite: Admission to medical curriculum or approval of department head.

924. Microbiology of Infectious Disease. (3-2). Credit 4. Basic microbiological principles and phenomena in relation to clinical manifestations in the human host. Interactions between microbial parasite and infected host, organized along organ system divisions. Prerequisites: MMIM 923; MANA 911.

985. Problems. Credit 1 or more. Directed individual study of advanced topics in microbiology and immunology. Prerequisites: MMIM 923, 924 and approval of department head.

991. Research. Credit 1 or more. Original laboratory investigation in specific areas of medical microbiology or immunology. Prerequisites: MMIM 923, 924 and approval of department head.

Department of Medical Pharmacology and Toxicology (MPHM)

601. Physiologic Pharmacology. (4-0). Credit 4. Pharmacologic effects of selected therapeutic agents on relevant physiology and pathophysiology of the heart, blood vessels and the eye; emphasis on integration of characteristic actions noted at the whole body or organ level with specific cellular and molecular mechanisms of action. Prerequisites: MPHM 924 and 925 or equivalents.

602. Chemical Pharmacology. (4-0). Credit 4. Application of theories of drug-receptor interaction to the classification of drugs and receptors and quantitation of drug action; computer analysis of dose-response and ligand-binding data; physiochemical factors influencing receptor activation by drugs. Prerequisites: CHEM 227, 228, 323, and 324; STAT 302 or equivalents.

603. Neuropsychopharmacology. (4-0). Credit 4. Pharmacology as it relates to behavior and the central nervous system. Prerequisites: MPHM 924 and 925 or equivalents.

604. Medical Toxicology. (4-0). Credit 4. Application of theoretical conceptual basis of chemical intoxication; mechanism of antagonism; computerized bibliographic retrieval of NLM and STN data banks; and intricacies of preparation of extramural grant proposals. Prerequisites: MPHM 924 and 925 or equivalents.

924. Medical Pharmacology I. Credit 3. General concepts of drugs and poisons; pharmacokinetics, autonomic drugs, cardiovascular agents and renal pharmacology. Prerequisites: Admission to medical curriculum or MPHY 901, 902; MANA 922; MBCH 911, 912.

925. Medical Pharmacology II. Credit 4. Continuation of MPHM 924; neuropsychopharmacology, chemotherapy and toxicology. Prerequisite: MPHM 924.

985. Problems. Credit 1 or more. Research in specialized areas of pharmacology. Prerequisites: MPHM 924 and approval of department head.

991. Research. Credit 1 or more. Individual research projects conducted under the direction of a supervising professor. Prerequisite: Approval of department head.

Department of Medical Physiology (MPHY)

604. Vascular Physiology. (4-0). Credit 4. Structure and function of blood vessels and vascular beds; molecular and cell biology of endothelium and vascular smooth muscle; microcirculation; capillary exchange; regulation of blood flow by local, neural and humoral signals. Prerequisite: MPHY 901 or approval of department head.

606. Physiology of the Heart. (4-0). Credit 4. Structure and function of the heart; molecular and cell biology of cardiac myocytes; electrophysiology of myocardium, pacemaker cells and conducting tissue; cardiac mechanics; control of cardiac performance; coronary circulation. Prerequisites: MPHY 901 and 604 or approval of department head.

608. Integrative Cardiovascular Physiology. (4-0). Credit 4. Overall regulation of cardiovascular system; interactions of heart and vascular system; cardiovascular neurophysiology and endocrinology; control of blood pressure, blood volume and cardiac output; integrated cardiovascular responses during exercise, gravitational stresses, temperature variations and hypoxia. Prerequisites: MPHY 901, 604, and 606 or approval of department head.

901. Medical Physiology I. (4-0). Credit 4. Systems of the human body with special emphasis on relationships between systems. Clinical cases exhibiting alterations in physiological feedback control. Prerequisite: Admission to medical curriculum or approval of department head.

902. Medical Physiology II. (4-3). Credit 5. Systems of the human body with emphasis on relationships between systems. Clinical cases exhibiting alterations in physiological feedback control. Laboratory experiences in human and mammalian systems. Prerequisites: MPHY 901 and admission to medical curriculum or approval of department head.

985. Problems. Credit 1 of more. Directed individual study of advanced topics in specialized areas of physiology. Prerequisites: MPHY 901, 902 and approval of department head.

991. Research. Credit 1 or more. Original investigation in specific areas of physiology. Prerequisites: MPHY 901, 902 and approval of department head.

Department of Pathology and Laboratory Medicine (MPAT)

923. Human Pathology I. Credit 4. Language of disease, identification of morphological lesions in common diseases and relation of their causes and pathogenesis to resulting clinical manifestations. Basic laboratory skills. Prerequisite: Year 1 of medical curriculum or approval of department head.

924. Human Pathology II. Credit 4. Human diseases, their causes, pathogenesis, lesions and resulting manifestations. Prerequisite: MPAT 923 or approval of department head.

925. Human Pathology III. Credit 4. Continuation of MPAT 923 and 924. Prerequisite: MPAT 924.

985. Problems in Pathology. Credit 1 or more. Special problems in pathology. Prerequisite: Year 1 of the medical curriculum or approval of department head.

991. Research. Credit 1 or more. The interest of the student and the supervising faculty member will determine the specific nature of the research. Prerequisites: Completion of years 1 and 2 of medical curriculum or approval of department head.

DEPARTMENT OF METEOROLOGY

K. C. Brundidge, P. Das, D. Djuric, D. M. Driscoll*, J. F. Griffiths, S. W. Lyons, J. P. McGuirk, G. R. North, R. L. Panetta, R. C. Runnels, J. R. Scoggins (Head)

*Graduate Advisor

Master of science and doctor of philosophy degrees are offered in meteorology as well as the bachelor of science degree. In addition to the Graduate College requirements, doctoral candidates may be required to pass (B average) up to 12 semester hours of course work in broadening subjects outside the major and minor fields. The student's graduate Advisory Committee shall determine whether one or more foreign languages shall be included in this work. All candidates for advanced degrees must pass a departmental qualifying examination as a condition for graduation.

Prerequisites for graduate work in meteorology are satisfied by the undergraduate program offered in the department. Anyone holding a bachelor's degree is eligible to enter the graduate program in meteorology. However, those entering the graduate program from another discipline will be required to complete a limited number of background courses. Most students can expect to complete a master's degree program in approximately two years. Students may emphasize marine, agricultural, radar, dynamical and numerical, physical, synoptic and mesoscale meteorology, climate modeling or climatology.

Meteorology. Meteorology is the science of planetary atmospheres and their phenomena. It concerns the study of internal and boundary layer atmospheric processes. The objective in meteorology is to determine the physical and chemical laws affecting atmospheres and to apply them in ways benefitting life and human endeavor. The greatest uses of weather information and forecasts have been in aviation, space exploration and travel, environmental quality and air pollution, and in the general public interest. Increasing rewards are being found in applications to agriculture, architecture, engineering, civil and industrial planning, health and travel, recreation, space exploration, air pollution and related sciences.

Persons with B.S. and M.S. degrees in meteorology typically obtain employment with government agencies, industrial organizations and consulting firms, or they may enter the meteorological branch of one of the military services. Their responsibilities might be in the accumulation and analysis of weather data, weather forecasting including television, air pollution meteorology, or in a closely allied area such as computer programming or agriculture. Positions in teaching and research almost exclusively require a graduate degree.

Facilities and Participation in Research. Graduate students often take an active part in one or more of the research contracts sponsored in the department by industry and by state and federal agencies. In addition to campus facilities, which include dual wavelength weather radars, Doppler radar, weather station with teletype and facsimile machines and satellite receiver, micrometeorological measurement facility, departmental computer, walk-in freezer room, and instrumentation and other special laboratories, others are available in the College of Geosciences for working at sea or a coastal location.

(METR)

600. Survey of Meteorology. (3-0). Credit 3. Survey course in meteorology designed for teachers of secondary school science. Prerequisite: Approval of department head.

615. Instrument Theory and Design. (3-0). Credit 3. Modern methods of instrumentation as related to meteorology and allied geophysical fields; their basic concepts, design, use and inherent errors. Prerequisite: Bachelor of science degree in science or engineering.

616. Remote Sensing of the Atmosphere. (3-0). Credit 3. Advanced methods of measurement in geoscience; meteorological parameters. Prerequisite: Approval of instructor.

625. Applied Climatology. (3-0). Credit 3. Practical applications of climate to other disciplines; methods used for this coordination. Prerequisite: METR 425 or approval of instructor.

629. Climate Change. (3-0). Credit 3. Climate of the geological and recent past; methods of assessing climate and climatic change; mechanisms, models, theories, impact and prediction of climatic change. Prerequisites: METR 425 or equivalent and approval of instructor.

636. Dynamic Meteorology. (3-0). Credit 3. General circulation; stratospheric dynamics; tropical systems. Prerequisite: METR 435.

637. Numerical Weather Prediction. (3-0). Credit 3. Numerical solution of meteorological equations, time and space differencing, non-linear stability, spectral approach. Prerequisite: METR 435 or registration therein.

638. Dynamics of Convective Clouds. (3-0). Credit 3. Parcel, slice and entrainment concepts; bubble and plume theories; spherical vortex; the starting plume; one-dimensional models; selected topics of current interest. Prerequisite: METR 435.

639. General Circulation of the Atmosphere. (3-0). Credit 3. Properties of the atmosphere's general circulation; dynamics of long waves; predictability, variability and forecasting of the general circulation; and regional interactions. Prerequisites: METR 435 and approval of instructor.

645. Cloud and Precipitation Physics. (3-0). Credit 3. Physics of atmospheric condensation nuclei, ice in the atmosphere; precipitation processes; artificial modification of clouds; precipitation. Prerequisite: METR 446.

647. Meteorology of the Upper Atmosphere. (3-0). Credit 3. Effects of solar system astrophysical processes and properties on extratropospheric terrestrial atmosphere. Composition, structures and characteristic phenomena. Prerequisite: Bachelor of science degree in meteorology, science or engineering.

655. Satellite Data in Meteorology. (3-0). Credit 3. Meteorological satellite programs of the U. S. and other countries; theory of meteorological measurements from artificial satellites; applications of satellite data in determinations of atmospheric structure and in forecasting; recent and current research studies; future programs. Prerequisite: METR 451 or approval of instructor.

656. Tropical Meteorology. (3-0). Credit 3. Role of the tropics in global circulation; structure and dynamics of the tropical zone; local and diurnal phenomena; synoptic components; tropical cyclones; role of cumulus-scale convection; current topics. Prerequisite: METR 451 or approval of instructor.

657. Mesometeorology. (3-0). Credit 3. Theory and structure of mesoscale weather systems and their relation to larger and smaller scale systems. Prerequisite: METR 451 or approval of instructor.

658. Synoptic Meteorology. (3-0). Credit 3. Mechanism and energetics of general circulation. Structure of large-scale systems. Persons desiring practice in analysis techniques should enroll for one or more hours of METR 685. Prerequisite: METR 453 or approval of instructor.

661. Atmospheric Turbulence. (3-0). Credit 3. Theory of atmospheric turbulence; production and dissipation of eddy energy; eddy energy equation; similarity theory; structure of turbulence. Prerequisites: MATH 308; METR 445 or approval of instructor.

662. Atmospheric Diffusion. (3-0). Credit 3. Models of atmospheric diffusion; plume rise; removal mechanisms; terrain influences; observational techniques; and long-range transport. Prerequisite: METR 661 or equivalent.

666. Agricultural Meteorology. (3-0). Credit 3. Application of physical concepts of meteorology to problems arising in agriculture; meso- and micro-climates and their modification. Prerequisite: METR 465 or approval of instructor.

681. Seminar. (1-0). Credit 1. Presented by students and faculty based upon their research work and upon surveys of the literature.

685. Problems. Credit 1 or more each semester. Offered to enable majors in meteorology to undertake and complete, with credit, in their particular fields of specialization, limited investigations not covered by any other courses in established curriculum.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of meteorology. May be repeated for credit.

691. Research. Credit 1 or more each semester. For thesis or dissertation. Topic subject to approval of department head.

MICROBIOLOGY
(See Biology)

DEPARTMENT OF MODERN AND CLASSICAL LANGUAGES

R. Bach, N. J. Bracher, C. C. Christian, Jr.*, L. B. Cooke, O. M. Cooke, L. F. Costa (Head), R. D. Critchfield, R. A. Crockett, R. K. Curry, N. J. Dyer, E. Espina, R. J. Golsan, M. C. Hawthorne, C. Hunting, W. Koepke, T. V. Laane, P. D. Laude, B. L. Lewis, S. J. Miller, T. Moore, S. M. Oberhelman, H. Puppe, K. C. Richards, E. H. Ritter, X. S. Shen, L. Stavenhagen, C. J. Steppich, E. Urbina

*Graduate Advisor

The Department of Modern and Classical Languages offers graduate courses leading to the degree of master of arts, with an option in Spanish, and courses in other languages preparing graduate students for the Ph.D. foreign language examinations. These latter courses (FREN 601, 602; GERM 603, 604; and SPAN 615, 616) may not be used for graduate credit.

The master of arts program offers courses in Peninsular Spanish literature, Spanish American literature and bilingualism. The thesis may be written in one of these areas. A minimum of six credit hours must be taken in a selected minor field. A non-thesis option is available.

Graduate work will directly prepare the student for professional careers concerned with Spanish and bilingualism, for teaching positions and for further graduate studies. A high competence in the Spanish language is required. This competence also assists the student in pursuit of professional employment outside of traditional areas.

Prerequisites: Admission to graduate studies and an undergraduate degree in Spanish or an equivalent competence in Spanish language and literature.

FRENCH
(FREN)

601. Introduction to Scientific French. (3-0). Credit 3. Intensive course to prepare graduate students to read scientific material. Technical vocabulary and translation. May not be used for graduate credit. Prerequisite: Graduate classification.

602. Readings in Scientific French. (3-0). Credit 3. Continuation of FREN 601. Reading and translation of material relating to various disciplines. Designed to develop technical vocabulary and facility in reading scientific French. May not be used for graduate credit. Prerequisite: FREN 601 or approval of department head.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the field of French. Prerequisite: Approval of department head.

GERMAN
(GERM)

603. Introduction to Scientific German. (3-0). Credit 3. Intensive course to prepare graduate students to read scientific material. Technical vocabulary and translation. May not be used for graduate credit. Prerequisite: Graduate classification.

604. Readings in Scientific German. (3-0). Credit 3. Continuation of GERM 603. Translation of material relating to various disciplines. Designed to develop technical vocabulary and facility in reading scientific German. May not be used for graduate credit. Prerequisite: GERM 603 or approval of department head.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the field of German. Prerequisite: Approval of department head.

SPANISH
(SPAN)

605. Spanish and the Bilingual Movement. (3-0). Credit 3. Problems of bilingualism with special reference to the Spanish-speaking population of the Southwest.

606. Spanish Language in Texas. (3-0). Credit 3. Sociocultural variables relating to Spanish usage in Texas; linguistic analysis of texts in which such usage is represented, as in the works of contemporary Chicano writers. Prerequisite: Graduate classification. Some knowledge of Spanish is desirable.

615. Introduction to Spanish Reading and Translation. (3-0). Credit 3. Reading professional material in the areas of the humanities, social sciences and related disciplines. Translation and reading for comprehension with emphasis on grammar and vocabulary. Not for graduate students in languages. May not be used for graduate credit. Prerequisite: Graduate classification.

616. Technical and Professional Readings in Spanish. (3-0). Credit 3. Reading professional material in the areas of the humanities, social sciences and related disciplines. Translation and readings for comprehension. Not for graduate students in languages. May not be used for graduate credit. Prerequisite: SPAN 615 or approval of department head.

635. Contemporary Spanish-American Prose. (3-0). Credit 3. Life and works of a selected Spanish-American novelist. Prerequisite: Twelve hours of advanced Spanish courses.

636. Contemporary Spanish Prose. (3-0). Credit 3. Life and works of a selected Spanish novelist. Prerequisite: Twelve hours of advanced Spanish courses.

646. Spanish Literature of the Golden Age. (3-0). Credit 3. Spanish drama and poetry from the Golden Age as well as selections from Don Quixote and the picaresque novel. Prerequisite: Twelve hours of advanced courses in Spanish.

647. Poetry of Spain and Spanish America. (3-0). Credit 3. Spanish and Spanish-American poetry; outstanding poets of the 20th century and analysis of contemporary techniques in writing poetry. Prerequisite: Twelve hours of advanced courses in Spanish.

648. Development of Spanish Literature and Culture. (3-0). Credit 3. Development of Spanish literature with selections from major authors interpreted in relation to the historical contexts. Prerequisites: Twelve hours of advanced courses in Spanish.

649. Literature, Society, and Culture in Latin America. (3-0). Credit 3. Society and culture of Latin American countries as represented in contemporary literature; the novel and the views of their societies expressed by Latin American writers in interviews, articles, essays and other forms. Prerequisite: Twelve hours of advanced courses in Spanish.

650. Structure of the Spanish Language. (3-0). Credit 3. Phonological and morphological structures of Spanish; regional and national variations. Prerequisite: Twelve hours of advanced courses in Spanish.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the field of Spanish language or literature. Prerequisite: Twelve hours of advanced Spanish courses.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of Spanish. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Thesis research credit given only upon acceptance of completed thesis. Prerequisite: Twelve hours of advanced courses in Spanish.

MUSIC
(See Philosophy and Humanities)

DEPARTMENT OF NUCLEAR ENGINEERING

F. R. Best*, W. E. Bolch*, R. G. Cochran*, C. A. Erdman*, R. R. Hart*, Y. A. Hassan*, W. H. Marlow*, M. E. McLain*, B. Nassersharif*, P. Nelson, Jr.*, T. A. Parish*, A. G. Parlos*, K. L. Peddicord*, J. W. Poston* (Head), G. A. Schlapper*

*Graduate Advisor

The continuing development of nuclear power and related industries has created a great and growing demand for trained nuclear engineers. The nuclear engineer is concerned with the release, control and use of energy from nuclear sources. Nuclear engineering is based on the principles of nuclear physics which govern radioactivity, fission and fusion; the production of heat and radiation in those processes; and the interaction of radiation with matter. The function of the nuclear engineer is to apply these principles to a wide range of challenging technological problems.

The Department of Nuclear Engineering offers the master of engineering, master of science and doctor of philosophy degrees. The department also offers courses and faculty supervision for students pursuing the doctor of engineering degree. Admission to nuclear engineering requires a bachelor's degree in engineering, chemistry, mathematics or physics. Some nuclear physics background is highly desirable. Mathematics through differential equations is required.

Degree programs which include a minor field of study are encouraged. This minor field would normally include graduate study in the area of the student's baccalaureate degree. If the baccalaureate degree is nuclear engineering, the student with the advice of his or her committee will select a suitable minor area of study. The department does not have a foreign language requirement for the Ph.D. degree; however, successful completion of a departmental qualifying exam after finishing the master's degree is required for continuation of studies for the Ph.D.

Research opportunities are varied with emphasis on nuclear fuels, solid/ion interactions, particle transport, reactor safety and design, thermal hydraulics, computational fluid mechanics, fusion engineering, reactor kinetics and control, space nuclear power systems, artificial intelligence and expert systems, and most areas of health physics.

The department offers a wide variety of facilities for instructional and research purposes. These include a well equipped radiation measurements laboratory, a subcritical reactor laboratory, access to AMDAHL 470 V/6, 470 V/7B, DEC VAX 8650 and 8800 computers and a university-wide VAX network, a departmental computer facility including a multi-noded network of Apple Macintoshes and SUN workstations, a radiochemistry laboratory, a thermal hydraulics laboratory, an AGN-201M low power nuclear reactor, a Cockcroft-Walton pulsed accelerator facility and a large TRIGA research reactor located at the Texas A&M University Nuclear Science Center. An 88-inch cyclotron is also available for research in nuclear physics and engineering at the Cyclotron Institute.

PROFESSIONAL EDUCATIONAL PROGRAM IN HEALTH PHYSICS

Students interested in doctoral level studies in health physics can pursue these through the Ph.D. program in nuclear engineering. In addition, a professional education program in health physics leading to the master of science degree in health physics, is available in the department.

This area of specialized study in the Department of Nuclear Engineering is based strongly on the fundamental aspects of radiation effects on matter, internal and external dosimetry and environmental aspects of nuclear power. The curriculum is such that students are trained at a professional level in the field of radiation safety or health physics.

A student is required to spend the initial academic year taking formal course work in the Department of Nuclear Engineering and in other cooperating departments of the University. The summer is spent in special courses providing practical on-the-job

training in health physics at the Cyclotron Institute, the Nuclear Science Center Reactor and at the Radiological Safety Office. At least one additional semester is normally required to finish course work and complete a research project for the master of science degree in health physics.

(NUEN)

601. Nuclear Reactor Theory. (3-0). Credit 3. Neutron energy spectra in infinite homogeneous media; diffusion approximation; one-speed and multigroup diffusion theory and criticality calculations for bare homogeneous reactors; reflected homogeneous reactors; changes in reactivity. Prerequisites: NUEN 404 or equivalent; MATH 601 or registration therein.

602. Nuclear Reactor Analysis. (3-0). Credit 3. Resonance absorption; reactor kinetics and reactivity control; temperature coefficients; perturbation theory; neutron transport. Prerequisites: NUEN 601, 604.

603. Advanced Nuclear Reactors. (3-0). Credit 3. Fast neutron interactions, neutron spectra (slowing down and thermalization), reactivity effects: void, Doppler and expansion. Kinetics and dynamics, comparison of fast and thermal gas cooled reactors. Breeding and conversion, fuel cycle economics. Existing advanced reactor experiments. Prerequisite: NUEN 601 or equivalent.

604. Radiation Interactions and Shielding. (3-0). Credit 3. Basic principles of radiation interactions and transport, especially as related to the design of radiation shields. Radiation sources, nuclear reactions, radiation transport, photon interactions, dosimetry, buildup factors and fast neutron shielding. Prerequisites: MATH 308, NUEN 202 or equivalent; B.S. in engineering or physical sciences.

606. Reactor Experimentation. (2-3). Credit 3. Extension of NUEN 405. Control rod and power calibrations are performed. Effects of scattering, absorption and moderation on the reactor are determined. Reactor core is disassembled and a critical experiment performed. Prerequisite: NUEN 405 or approval of graduate advisor.

607. Thermonuclear Engineering. (3-0). Credit 3. Fusion reactions, orbit theory in magnetic and electric fields. Coulomb interactions, formulation of Boltzmann equation, magnetohydrodynamics, plasma waves. Prerequisite: MATH 601 or registration therein, NUEN 417, or approval of instructor.

608. Thermonuclear Engineering. (3-0). Credit 3. Fundamentals relative to use of fusion reaction as energy source. Transport theory for ionized gases. Liouville and Boltzmann equations. Macroscopic conservation laws and magnetohydrodynamics. Instabilities. Confinement and heating problems. Diagnostics. Prerequisite: NUEN 607.

609. Nuclear Reactor Safety. (3-0). Credit 3. Analysis and evaluation applied to reactor design for accident prevention and mitigation; protective systems and their reliability, containment design, emergency cooling requirements, reactivity excursions and the atmospheric dispersion of radioactive material; safety problems associated with light-water power reactors and proposed fast reactor systems. Prerequisites: NUEN 601, 623, or consent of instructor.

610. Design of Nuclear Reactors. (4-0). Credit 4. Application of fundamentals of nuclear physics and reactor theory with engineering fundamentals to design of nuclear reactors. Prerequisites: NUEN 602 or registration therein, NUEN 410 or approval of instructor.

612. Radiological Safety and Hazards Evaluation. (3-0). Credit 3. Rigorous mathematical and physical approach to various aspects of radiological safety. Derivation of equations involving radiation absorption, radiation dosimetry and calculations of radiation dose due to internal emitters. Mathematical models developed for determination of maximum permissible body burdens and concentrations in air and water. Prerequisites: MATH 308, NUEN 613.

613. Principles of Radiological Safety. (3-0). Credit 3. State and federal regulations concerning radioactive materials. Radiation safety as applied to accelerators, nuclear reactors and radioactive byproducts. Rigorous methods of analysis applied to computation of biological radiation dose and dose rates from various sources and geometries. Radiation effects on physical systems. Prerequisite: NUEN 409.

618. Nuclear Control Systems. (3-0). Credit 3. Reactor kinetics and fundamentals of servo-control developed and applied to nuclear reactors. Safety aspects of reactor control and operational problems. Prerequisite: NUEN 602 or registration therein.

622. Nuclear Power Plant Design and Analysis. (3-0). Credit 3. Application of nuclear reactor systems to field of power production, using general fields of thermodynamics and heat transfer, with special problems arising from nuclear system. Prerequisites: MEEN 323 or 327; NUEN 610 or registration therein.

623. Nuclear Engineering Heat Transfer and Fluid Flow. (3-0). Credit 3. Thermodynamics and unified treatment of mass, momentum and energy transport with applications to nuclear engineering systems; velocity and temperature distributions in laminar and turbulent flow; flow and thermal stability. Prerequisites: MATH 601 or registration therein; MEEN 334, 346 or 461; or approval of instructor.

624. Nuclear Thermal Hydraulics and Stress Analysis. (3-0). Credit 3. Unified treatment of advanced heat transport in solids and fluids including boiling phenomena; thermal stress phenomena with applications to nuclear sources; isothermal elasticity; thermoelasticity; viscoelasticity; plasticity. Prerequisites: MATH 601 or registration therein; NUEN 623 or equivalent.

625. Neutron Transport Theory. (4-0). Credit 4. Analytical treatment of neutron transport theory. Solution methods of integrodifferential and integral Boltzmann equations, adjoints; energy dependent methods using singular eigenfunctions, variational methods, orthogonal polynomials and thermalization; current analytical techniques in transport theory. Prerequisites: MATH 602; NUEN 602.

629. Numerical Methods in Reactor Analysis. (4-0). Credit 4. Solution of variable dimension multigroup discrete representation problems including S^n, P^n, A^n, variational and Monte Carlo techniques; techniques in reactor kinetics, fuel cycle and optimization. Prerequisites: NUEN 429, 602 or equivalent.

675. Internal Dose Techniques. (3-0). Credit 3. Current and proposed techniques for assessing the absorbed dose due to internally deposited radionuclides; techniques recommended for international and national bodies, as well as those used in nuclear medicine. Prerequisites: NUEN 612, 613.

676. Health Physics Instrumentation. (1-6). Credit 3. Advanced course in health physics instrumentation intended for students pursuing graduate study in health physics. Provides an in-depth knowledge of the components of radiation monitoring and measurement systems. Prerequisite: NUEN 402.

679. Practical Applications of Radiological Safety I. (1-6). Credit 3. Intensive and comprehensive lecture and practical training in radiological safety operations. Radioactive license application, review and compliance. Actual performance of radiation safety duties at isotope laboratories, counting laboratories, nuclear reactors and high energy accelerators. Prerequisites: NUEN 612, 613.

680. Practical Applications of Radiological Safety II. (1-6). Credit 3. Continuation of NUEN 679 reaching point where student can design and conduct radiation surveillance operations independently, with no immediate supervision. Prerequisite: NUEN 679.

681. Seminar. (1-0). Credit 1. Special topics in nuclear engineering not covered by formal course work. Whenever possible, guest lecturers will discuss topics which they have personally investigated. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Offered to enable students to undertake and complete limited investigations not within their thesis research and not covered by any other courses in curriculum. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of nuclear engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research toward thesis or dissertation.

NUTRITION

C. A. Bailey, G. W. Bates, F. M. Byers, R. S. Chapkin, C. E. Coppock, C. R. Creger*, C. W. Dill, R. L. Edwards**, W. C. Ellis, L. W. Greene, P. S. Hargis, E. D. Harris, J. H. Hesby, D. P. Hutcheson, D. A. Knabe, K. S. Kubena, H. O. Kunkel***, J. R. Lupton, D. N. McMurray, B. C. O'Brien, T. W. Odom, G. D. Potter, G. C. Smith, S. B. Smith, E. M. Sudweeks, C. Vanderzant, R. D. Wood

*Graduate Advisor for Poultry Nutrition
**Graduate Advisor for Animal Nutrition
***Graduate Advisor for Human Nutrition

The graduate programs in nutrition allow emphases in animal, human and fundamental nutritional sciences. They include biochemical and physiological studies that

are concerned with the interaction and metabolism of nutrients and the availability of nutrients from foods. Studies in animal nutrition may be related to animal agriculture and aquaculture or may be fundamental in nature. Research also may include the cultural and social aspects of nutrition.

Participating in the M.S. and Ph.D. degree programs are the Departments of Animal Science, Poultry Science, and Biochemistry and Biophysics. Contributory courses are offered in the Departments of Veterinary Pathology and Wildlife and Fisheries Sciences.

(NUTR)

630. Nutrition in Disease. (3-0). Credit 3. Human nutritional requirements in health and disease, emphasizing effects of disease states on intake, digestion, absorption, metabolism and excretion of nutrients. Relationship of diet to development of certain diseases. Prerequisite: NUTR 202, BICH 410 or equivalent.

635. Nutrition and the Development of Specific Tissues. (3-0). Credit 3. Nutritional factors in the development of animal tissues; examination of nutrients that influence chondrogenesis, osteogenesis, muscle, nervous and adipose tissue development. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603.

640. Biomineralization in Animals. (3-0). Credit 3. Factors involved in the process of biomineralization; role of nutrients, physiological processes and environment in normal and abnormal biomineralization. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603. Cross-listed with POSC 640.

641. Nutritional Biochemistry. (3-0). Credit 3. Mechanisms of nutrient digestion, absorption, transport assimilation and utilization in the normal and diseased state. Prerequisite: BICH 411 or 604. Cross-listed with BICH 641.

645. Nutrition and Metabolism of Vitamins. (3-0). Credit 3. Chemistry and metabolism of the fat soluble and water soluble vitamins and their roles in animals; integrates cellular biochemistry and metabolism of the vitamins in vertebrate animal. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603. Cross-listed with POSC 645.

650. Nutrition and Metabolism of Minerals. (3-0). Credit 3. Nutritional significance of minerals in animal metabolism; chemical, biochemical and physiological role of minerals and homeostatic control in animal metabolism. Prerequisites: POSC 411 or ANSC 303 and BICH 410 or 603. Cross-listed with POSC 650.

681. Seminar. (1-0). Credit 1. Current developments in the field of human nutrition. Review of current literature and oral presentation of scientific papers on selected nutrition topics. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4. Experience in application of formal training to applied nutrition under supervision of nutritionists, dietitians and faculty member. Student will investigate matter of mutual interest and report results in a professional paper approved by the graduate committee. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Human nutrition problems and procedures. Problems assigned according to experience, interest and needs of individual student. Prerequisite: Approval of instructor prior to registration.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of human nutrition. May be repeated for credit. Prerequisites: Graduate classification and approval of instructor.

691. Research. Credit 1 or more each semester. Investigations leading to thesis or dissertation in various areas of human nutrition. Prerequisite: Graduate classification.

DEPARTMENT OF OCEANOGRAPHY

J. W. Ammerman, A. L. Anderson, E. L. Atlas, J. G. Baldauf, L. Berner, Jr., R. R. Bidigare, D. C. Biggs, P. N. Boothe, T. J. Bright, D. A. Brooks, J. M. Brooks, W. R. Bryant, L. Cifuentes, J. D. Cochrane, R. Darnell*, S. Z. El-Sayed, D. A. Fahlquist, R. R. Fay, G. A. Fryxell, W. D. Gardner, L. E. Garrison, S. Gartner*, E. E. Hofmann, T. Ichiye, M. C. Kennicutt II, J. M. Klinck, J. D. McEachran, W. J. Merrell, J. W. Morse, G. R. North, W. D. Nowlin, Jr., E. N. Powell, B. J. Presley, P. D. Rabinowitz, R. O. Reid*, R. Rezak, G. T. Rowe (Head), W. W. Sager, P. H. Santschi, D. R. Schink*, J. R. Schwarz, M. R. Scott, A. C. Vastano, T. L. Wade, J. S. Watkins, J. H. Wormuth

*Graduate Advisor

Degrees. Degrees of master of science and doctor of philosophy are offered in oceanography.

Oceanography. Oceanography is the interdisciplinary science that focuses on the ocean, its contents and its boundaries. Whereas typical graduate programs lead to progressively greater amounts of specialization, oceanography as an interdisciplinary field admits graduates of specialized areas such as biology, chemistry, geology, mathematics, physics or engineering and initially generalizes and broadens their education with a core of required courses. These core courses include the four specializations of the oceanography program — biological, chemical, geological/geophysical and physical oceanography — as well as a techniques course and a seminar covering the state of the science. After this exposure to the interdisciplinary nature of oceanography, the graduate student refocuses in his or her particular subject area to pursue research at the leading edge of the science. In addition, a special program in multidisciplinary ocean modeling exists.

Required prerequisites are the equivalent of a B.S. degree in one of the basic fields mentioned above and basic courses in each of the other areas. All students are expected to have had mathematics through integral calculus, at least one year each of physics and chemistry, and at least one survey course in biology and geology. These are in addition to the usual amount of course work in their major field of science or engineering.

To qualify for an advanced degree in oceanography, the student must demonstrate an ability to apply basic science to the marine environment. This capability requires a combination of principles and methods and a certain body of knowledge unique to oceanography; a student of oceanography must become conversant in all of the marine sciences.

Facilities and Participation in Research. Facilities include office, laboratory and classroom space in the 15-story David G. Eller Building for Oceanography and Meteorology on the College Station campus; space at the Texas A&M University Riverside Campus; office, shop and dock facilities on Pelican Island in Galveston, Texas; the R/V *Gyre*, a 182-foot oceangoing research vessel; a 2,000-foot water depth Remote Operated Vehicle (ROV) outfitted for science researchers; a VAX II-750 computer and a large research equipment inventory. Graduate students usually take an active part in research grants and contracts awarded to individual professors and research teams by federal and state agencies, industry and private foundations. Texas A&M University and the University of Texas recently signed an agreement creating a joint marine operations facility. This agreement provides for joint use of vessels and ship use scheduling through a single marine operations office.

Required Courses. OCNG 602, 608, 620, 630 and 640 and two hours of oceanography seminar (OCNG 681) are required of all graduate students who are candidates for M.S. and Ph.D. degrees. A reading knowledge of one modern foreign language is required of all Ph.D. candidates. Further information is available from the department.

(OCNG)

600. Survey of Oceanography. (3-0). Credit 3. General survey of the scientific framework of oceanographic study. Applications of ocean research to social and economic problems; interrelations between the ocean disciplines and other fields of study. Prerequisite: Approval of instructor.

602. Ocean Research and Operational Techniques. (1-5). Credit 3. Technical, operational and legal aspects of sea-going research operations. Planning and executing ocean research operations. Practice in techniques and equipment regularly used aboard ships; familiarization with acquisition and processing of data. Prerequisite: Approval of instructor.

604. Biological Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in biological oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

605. Chemical Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in chemical oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

606. Geological Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in geological oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

607. Physical Oceanography Cruise. Credit 2. Specialized experience in research methods and analysis in physical oceanography via preparation for and participation in a research cruise of at least two weeks duration under the supervision of a Texas A&M oceanography faculty member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidates. Prerequisite: Approval of instructor.

608. Physical Oceanography. (3-2). Credit 4. Observations, instruments; physical properties of seawater. Property distributions; characteristics of water masses; heat budget. Kinematics; gravity, pressure, hydrostatics, stability. Horizontal flow; Coriolis force, geostrophy; friction, wind drift; general circulation. Wave motions; tides. Prerequisites: MATH 122 or equivalent; PHYS 219.

609. Physical Oceanography. (3-0). Credit 3. Kinematics of fluids, systematic derivation of the equations of motion and continuity; general integral relations; thermodynamic considerations of seawater; non-equilibrium transfer processes and the second law of thermodynamics. Prerequisites: MATH 601; METR 435 or OCNG 608 (concurrently).

610. Mathematical Modeling of Marine Ecosystems. (3-0). Credit 3. Theory and technique of model development for marine ecosystems; mathematical representation of interactions among nutrients, phytoplankton, zooplankton, fish and the physical environment; scrutiny of biological concepts and mathematical structure of existing models. Prerequisites: OCNG 608 and 620, calculus or approval of instructor.

611. Theoretical Physical Oceanography. (3-0). Credit 3. Application of vorticity equation to ocean circulation; meanders and Rossby waves; inertio-gravity waves and other wave phenomena in the ocean including boundary waves. Prerequisites: OCNG 608, 609.

612. Elements of Ocean Wave Theory. (3-0). Credit 3. Theories of simple harmonic surface gravity, capillary and internal waves. Wave propagation, dispersion and energy. Modifications due to rotation, variable depth and finite amplitude. Prerequisites: MATH 601; OCNG 608; or approval of instructor.

614. Dynamics of the Ocean and Atmosphere. (3-0). Credit 3. Time-dependent motions in rotating, stratified fluids, with application to the ocean; Boussinesq and betaplane approximations; circulation, vorticity and energy conservation; Kelvin, Poincaré and Rossby waves; tidal forcing and response; quasi-geostrophic potential vorticity; concepts of barotropic and baroclinic instability. Offered in 1987-88 and alternate spring semesters thereafter.

617. Theories of Ocean Circulation. (3-0). Credit 3. Theories of wind-driven circulation, Sverdrup solution, frictional and inertial boundary regimes; instabilities, meanders and mesoscale features. Role of stratification, topography and time dependence. Thermohaline circulation. Offered in 1987-88 and alternate years thereafter. Prerequisite: OCNG 611 or approval of instructor.

618. Acoustical Oceanography. (3-0). Credit 3. Underwater sound and remote sensing of the interior and boundaries of the ocean; acoustic fundamentals such as units, source level, transmission loss, ambient noise and scattering studied by examining specific oceanographic acoustic sensing methods including tomography, inverted echo sounders, quantitative backscattering and biomass assessment. Prerequisite: MATH 601 or approval of instructor.

620. Biological Oceanography. (3-0). Credit 3. Critical analysis of contribution of biological science to our understanding of sea. Discernible interrelationships between organisms and physicochemical parameters. Prerequisite: General prerequisites for oceanography.

621. Open-Ocean Physiological Ecology. (2-3). Credit 3. Metabolic adaptations and biochemical responses exhibited by open-ocean plankton and benthos to high hydrostatic pressure, low temperature and oxygen minima stresses. Nutritional ecology and ecological bioenergetics of oligotrophic oceanic systems. Prerequisite: OCNG 620 or graduate classification in oceanography, biology or wildlife and fisheries sciences.

622. Analysis of Benthic Communities. (2-3). Credit 3. Comprehensive study of marine benthos with principal emphasis upon Gulf of Mexico and Caribbean Sea. Offered in 1988-89 and alternate years thereafter. Prerequisite: OCNG 620 or equivalent.

623. Marine Zooplankton. (2-3). Credit 3. Descriptive material on zooplankton populations of the world's oceans. Feeding, growth, reproduction and predator-prey interrelationships. Laboratory deals with organism morphology necessary for taxonomic identifications using mainly Gulf of Mexico material. Prerequisite: OCNG 620 or equivalent.

624. Marine Phytoplankton. (2-3). Credit 3. Detailed studies of phytoplankton; physical and chemical factors which affect plankton production. Phytoplankton-zooplankton relationship, sampling problems. Prerequisite: OCNG 620 or equivalent.

627. Ecology of the Continental Shelf. (3-0). Credit 3. Environments, populations and communities of the continental shelf. Interactions of the shelf with the estuaries and the deep sea; man's impact on the shelf ecosystems. Prerequisite: Approval of instructor.

628. Biology of Coral Reefs. (2-2). Credit 3. Ecology, zonation, community structure and ethology of coral reefs with emphasis on those in the Atlantic and adjacent seas. Laboratory familiarization with faunal components. Prerequisite: Graduate classification in oceanography, biology, or wildlife and fisheries sciences or approval of instructor.

630. Geological Oceanography. (3-0). Credit 3. Survey of marine geology, structure and composition of ocean basins and continental margins, properties of marine sediments. Prerequisite: General prerequisites for oceanography.

633. Carbonate Sediments I. (1-3). Credit 2. Detailed examination of skeletal microstructures of carbonate producing organisms and recognition of these organisms through practical identification in carbonate sediments. Prerequisite: Approval of instructor.

634. Carbonate Sediments II. (2-3). Credit 3. Composition, classification and distribution of carbonate sediments; processes of carbonate sedimentation and diagenesis. Laboratory work includes study of both recent and ancient carbonates. Offered in spring semester 1988 and alternate years thereafter. Prerequisite: Approval of instructor.

635. Techniques in Geological Oceanography. (2-2). Credit 3. Shipboard and laboratory techniques used in geological oceanography: sampling peels, impregnation, thin sectioning, imbedding, radiography, staining, geotechnical properties, photography, microscopy, photomicrography, granulometry, profiling, cruise preparation. Two field trips required for which departmental fee may be required to cover costs. Prerequisite: Approval of instructor.

636. Marine Biostratigraphy I. (2-3). Credit 3. Survey of all microfossil groups useful for the biostratigraphic study of marine sediments. Biostratigraphic concepts, systematics (including ecology and evolution), morphology and distribution of microfossil groups. Laboratory emphasis is on techniques and biostratigraphic use. Prerequisite: Invertebrate paleontology, stratigraphy, or approval of instructor.

637. Marine Biostratigraphy II. (2-3). Credit 3. Calcareous nannofossil biostratigraphy and zonal succession, correlation with stratotypes, the paleomagnetic record and absolute chronology of the Jurassic to Recent. Prerequisite: OCNG 636 or approval of instructor.

638. Simulation Techniques. (2-6). Credit 4. Numerical simulation of geophysical fluid dynamic phenomena; barotropic and baroclinic fluids, inertio-gravitational and planetary waves; quasi-geostrophic circulation. Offered in spring semester 1989 and alternate years thereafter. Prerequisite: Approval of instructor.

639. Lithophycology. (2-3). Credit 3. Morphology, taxonomy and ecology of calcareous algae and stromatolites and their role as builders of limestones. Laboratory work includes identification of both recent and fossil species. Offered in 1988-89 and alternate years thereafter. Prerequisite: Approval of instructor.

640. Chemical Oceanography. (3-2). Credit 4. Chemical composition and properties of seawater, evaluation of salinity, pH, excess base and carbon dioxide in sea. Marine nutrients, oxygen and other dissolved gases, organic constituents. Laboratory exercises on routine analyses. Prerequisites: General prerequisites for oceanography.

641. Chemical Oceanography. (3-0). Credit 3. Selected topics in chemical oceanography; thermodynamics of electrolyte solutions, absorption, diffusion and the carbonate system. Offered in 1987-88 and alternate years thereafter. Prerequisite: Degree in chemistry or approval of instructor.

642. Marine Chemistry of the Nutrient Elements. (2-3). Credit 3. Descriptions of the nutrient element cycles in the sea: inputs; biological interactions; use as tracers; removal processes. Silicon, phosphorous, nitrogen. Prerequisite: OCNG 640 or approval of instructor.

643. Geochemistry of the Ocean. (3-0). Credit 3. Chemical behavior of naturally occurring materials at earth surface conditions and the processes which control the chemical composition of seawater and marine sediments. Prerequisite: Undergraduate major in geology or approval of instructor.

644. Isotope Geochemistry. (3-0). Credit 3. Stable and radioactive isotope variations in natural materials. Applications to geochronometric, geothermometric and paleoclimatologic studies of the marine environment. Offered in 1988-89 and alternate years thereafter. Prerequisite: Approval of the instructor.

645. Marine Organic Geochemistry. (3-0). Credit 3. Origins, fates and distribution of organic compounds in contemporary marine environments and in recent and ancient sediments. Specific analytical techniques. Prerequisite: Approval of instructor.

646. Techniques in Marine Geochemistry. (2-4). Credit 3. Practical techniques for collecting and preserving marine sediments, water and organisms and for determining their elemental and isotopic composition. Prerequisites: Quantitative and instrumental analysis, or approval of instructor.

647. Chemical Contamination of the Marine Environment. (3-0). Credit 3. Assessment of the inputs, transfers, effects and fates of heavy metals, radio-nuclides, petroleum hydrocarbons, chlorinated hydrocarbons and other chemicals in the ocean. Models developed to predict the future viability of the ocean with particular emphasis on the Gulf of Mexico. Offered in 1988-89 and alternate years thereafter. Prerequisite: Approval of instructor.

648. Carbonate Geochemistry in Sedimentary Environments. (3-0). Credit 3. Mineralogy and chemical properties of sedimentary carbonates; biogenic carbonate chemistry; the carbonic acid system in natural waters; equilibrium and non-equilibrium carbonate-solution interactions; present marine carbonate system; impact of fossil fuel CO_2; early diagenesis of shallow water carbonates; cementation reactions; dolomitization. Prerequisite: Approval of instructor.

651. Meteorological Oceanography. (3-0). Credit 3. Interaction between the ocean and atmosphere. Major features of the two systems. Heat budget, teleconnections between ocean and atmosphere, El Nino and related phenomena. Prerequisites: METR 445 or OCNG 608.

653. Synoptic Physical Oceanography. (2-2). Credit 3. Methods of analysis and description of major water masses. Variations in ocean circulation, vertical motion and spreading of water masses, abyssal circulations. Formation of deep waters especially in the Norwegian-Greenland Seas. Prerequisite: OCNG 608.

656. Satellite Oceanography. (3-0). Credit 3. Theory and application of satellite observation for oceanic phenomena utilizing visible, infrared and microwave sensors; detection, measurement, quantitative analysis, joint satellite-numerical assessment of structural and dynamic feature evolution, and correction with surface-borne field experiments and measurements. Prerequisites: OCNG 608, 620, 630, 640 or approval of instructor.

661. Plate Tectonics: History and Practice. (3-0). Credit 3. Discoveries, concepts and scientific environment that led to the theory of plate tectonics from readings of pioneering and fundamental papers. Focuses on geological case studies of regions that typify and elucidate tectonic plate processes, boundaries and interactions. Prerequisite: MATH 601 or approval of instructor.

662. Marine Sedimentary Processes I. (3-2). Credit 4. Geophysical fluid dynamics as it pertains to sedimentary processes. Erosion, transportation and deposition from shoreline to the middle of the continental shelf. Prerequisite: Undergraduate degree in geology or approval of instructor.

663. Marine Sedimentary Processes II. (3-0). Credit 3. Sedimentary processes taking place in the sea from midshelf to deep ocean basin. Prerequisite: Undergraduate degree in geology or approval of instructor.

664. Field Course in Marine Soft-Bottom Communities. (1-3). Credit 2. Field course stressing community composition, trophic structure, animal sediment interactions. Biological and physical factors controlling community structure in soft-bottom communities. Taught entirely at the coast and consists of 1-2 day-long trips with lecture and lab. Prerequisites: OCNG 620 and 622 and approval of instructor.

665. Invertebrate Biochemistry and Biochemical Ecology. (3-0). Credit 3. Biochemistry of marine invertebrates; biochemical adaptations to life in the oceans and evolution of biochemical systems in invertebrates. Prerequisites: BICH 603 and 604 or approval of instructor.

666. Principles of Geodynamics. (4-0). Credit 4. Geological and geophysical methods and phenomena pertinent to geodynamics. Plate tectonics; seismicity and seismology; magnetics; gravity; heat flow; igneous, metamorphic and sedimentary petrology; paleontology; and rock mechanics. Prerequisite: Approval of instructor. Cross-listed with GEOL 666 and GEOP 666.

667. Seismic Stratigraphy of the Ocean Basins. (3-3). Credit 4. Geological interpretation of marine seismic reflection profiling data constrained by the physical and acoustic properties of marine sediments. Geological interpretation methods with several exercises on seismic reflection profiles. Prerequisites: GEOP 435, 436 or equivalent.

668. Geology and Geophysics of Small Ocean Basins. (3-0). Credit 3. Geology and geophysics of the Gulf of Mexico, Caribbean, Mediterranean, Arctic Ocean, Red Sea and Philippine Sea; the regional geology, sediment distribution, general structure and origin of each basin. Prerequisite: OCNG 630.

670. Comparative Analysis of Marine Phytoplankton. (2-3). Credit 3. Microscopic plants that form the base of the marine food chain; field samples and cultures; morphological studies involving light and scanning electron microscope projects; comparative analysis of field samples; current literature topics and research direction. Prerequisite: OCNG 620 or approval of instructor.

671. Geotechnical Properties of Fine-Grained Marine Sediments. (3-0). Credit 3. Geotechnical properties of marine sediment masses ranging from high-water-content muds to low-porosity shales. Genesis and diagenesis of marine sediment masses and their relationship to various physical properties; the formation of mudstones and shales; fluid migration in consolidating sediment masses. Prerequisite: OCNG 630 or approval of instructor.

681. Seminar. (1-0). Credit 1. Presented by faculty, students, staff and visiting scientists. Based on recent scientific research.

685. Problems. Credit 1 to 4 each semester. Special topics to suit small group requirements. Problems not within thesis research and not covered by any other course in established curriculum. Prerequisite: General prerequisites for oceanography.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of oceanography. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. For thesis or dissertation. Topic subject to approval of department head.

DEPARTMENT OF PETROLEUM ENGINEERING

J. C. Calhoun, Jr., P. B. Crawford, S. A. Holditch, J. W. Jennings, H. C. Juvkam-Wold, W. J. Lee, J. S. Osoba, L. D. Piper, S. W. Poston, R. Raghavan, J. T. Rollins, J. E. Russell, R. A. Startzman*, W. D. Von Gonten* (Head), M. P. Walsh, R. A. Wattenbarger, R. L. Whiting, C. H. Wu

*Graduate Advisor

Graduate work in petroleum engineering is offered at both the master's and doctoral levels. At the master's level, courses are offered with the primary aim of developing the skills required to analyze and forecast the performance of petroleum reservoirs and their behavior under conditions imposed by pressure depletion, pressure maintenance, enhanced recovery operations and cycling. Courses are also given which deal with analysis of production and drilling operations. Research is conducted in all these areas.

At the doctoral level, curricula are offered to give the student a broad understanding of the various phases of the petroleum industry as well as the ability to investigate and solve technical problems arising in the industry by original research. Laboratory facilities are available for advanced studies on all phases of reservoir equilibrium and mechanics, including equipment for work on permeability-saturation relationships, core analysis and interpretation, secondary recovery, enhanced recovery, hydraulic fracture treatment design and model reservoir studies. Equipment is also available for investigating problems arising in subsurface engineering. Much special equipment has been provided for the study of reservoir behavior at high pressures and temperatures.

A strong area of study is offered dealing with the development and use of numerical models for simulating field and/or well performance for a wide range of operating conditions.

Computers are used extensively in all graduate courses and research.

(PETE)

602. Well Completions. (3-3). Credit 4. Completion and production problems of oil and gas wells. Prerequisite: Approval of department head.

603. Advanced Reservoir Engineering I. (3-3). Credit 4. Petroleum reservoir simulation basics including solution techniques for explicit problems. Prerequisite: Approval of department head.

604. Advanced Reservoir Engineering II. (3-3). Credit 4. Advanced petroleum reservoir simulation with generalized methods of solution for implicit problems. Prerequisite: PETE 603.

605. Phase Behavior of Petroleum Reservoir Fluids. (3-0). Credit 3. Pressure, volume, temperature, composition relationships of petroleum reservoir fluids. Prerequisite: Approval of department head.

606. EOR Methods—Thermal. (3-0). Credit 3. Fundamentals of enhanced oil recovery (EOR) methods and applications of thermal recovery methods. Prerequisites: PETE 428 and approval of department head.

607. EOR Methods—Chemical and Miscible. (3-0). Credit 3. Basics and applications of chemical and miscible methods for enhancement of oil recovery from oil reservoirs. Prerequisites: PETE 428 and approval of department head.

608. Well Logging Methods. (2-3). Credit 3. Well logging methods for determining nature and fluid content of formations penetrated by drill. Development of computer models for log analysis. Prerequisite: Approval of department head.

610. Numerical Simulation of Heat and Fluid Flow in Porous Media. (2-6). Credit 4. Various schemes available for the numerical simulation of heat and fluid flow in porous media. Application to hot water and steam flooding of heavy oil reservoirs and to various geothermal problems. Prerequisite: PETE 604.

611. Application of Petroleum Reservoir Simulation. (2-6). Credit 4. Use of simulators to solve reservoir engineering problems too complex for classical analytical techniques. Prerequisites: PETE 428, 438.

612. Advanced Reservoir Simulation and Optimization. (3-0). Credit 3. Recent techniques for reservoir pressure/saturation determination. Simulation of gas flow from co-mingled reservoirs including tubing and pipe flow and field compression. Analysis of gas fields to meet seasonal and long-term schedules. Prerequisite: PETE 603.

613. Natural Gas Engineering. (4-0). Credit 4. Flow of natural gas in reservoirs and in wellbores and gathering systems; deliverability testing; production forecasting and decline curves; flow measurement and compressor sizing. Prerequisites: PETE 438, 448.

614. Sucker Rod Pumping. (3-0). Credit 3. Analysis of sucker rod pumping systems using the API RP11L method, analytical and numerical solutions to the wave equation, and kinematic analysis of the surface unit. Prerequisite: PETE 414.

616. Engineering Near-Critical Reservoirs. (3-0). Credit 3. Identification of reservoir fluid type; calculation of original gas in place, original oil in place, reserves and future performance of retrograde gas and volatile oil reservoirs. Prerequisite: PETE 428.

619. Facilities Network Modeling. (3-0). Credit 3. Introduction to the theory, construction and application of network modeling methods used to predict the pressure/rate behavior of single- and multiphase oilfield facility systems. Prerequisite: PETE 413.

620. Fluid Flow in Petroleum Reservoirs. (3-0). Credit 3. Analysis of fluid flow in bounded and unbounded reservoirs, wellbore storage, phase redistribution, finite and infinite conductivity fractures; dual-porosity systems. Prerequisite: PETE 448.

621. Petroleum Development Strategy. (2-3). Credit 3. Applications of the variables, models and decision criteria used in modern petroleum development. The case approach will be used to study major projects such as offshore development and assisted recovery. Both commercial and student-prepared computer software will be used during the lab sessions to practice methods. Prerequisite: PETE 402.

622. Exploration and Production Evaluation. (2-3). Credit 3. Selected topics in oil industry economic evaluation including offshore bidding, project ranking and selection, capital budgeting, long-term oil and gas field development projects and incremental analysis for assisted recovery and acceleration. Prerequisite: PETE 402 or 403.

623. Waterflooding. (3-0). Credit 3. Design, surveillance and project management of waterfloods in reservoirs. Prerequisite: PETE 428 or 458.

624. Rock Mechanic Aspects of Petroleum Reservoir Response. (3-0). Credit 3. Reservoir rocks and their physical behavior. Porous media and fracture flow models. Influence of rock deformability, stress, fluid pressure and temperature. Prerequisite: PETE 604.

625. Well Control. (3-0). Credit 3. Theory of pressure control in drilling operations and during well kicks; abnormal pressure detection and fracture gradient determination; casing setting depth selection and advanced casing design; theory supplemented on well control simulators. Prerequisite: PETE 405.

626. Offshore Drilling. (3-0). Credit 3. Offshore drilling from fixed and floating drilling structures; directional drilling including horizontal drilling; theory of deviation monitoring and control. Prerequisite: PETE 405.

627. Drilling Fluids and Cementing. (3-0). Credit 3. Composition and properties of drilling fluids; effect of additives on fluid properties; drilling fluid hydraulics; cements and cementing. Prerequisite: PETE 405.

648. Pressure Transient Testing. (4-0). Credit 4. Diffusivity equation and solutions for slightly compressible liquids. Dimensionless variables. Type curves. Applications of solutions to buildup, drawdown, multi-rate, interference, pulse and deliverability tests. Extensions to multiphase flow. Analysis of hydraulically fractured wells. Prerequisite: PETE 448.

681. Seminar. (1-0). Credit 1 each semester. Study and presentation of papers on recent developments in petroleum technology. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 12 each semester. Offered to enable students to undertake and complete limited investigations not within their thesis research and not covered in established curricula. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of petroleum engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Advanced work on some special problem within field of petroleum engineering. Thesis course. Prerequisite: Approval of department head.

DEPARTMENT OF PHILOSOPHY AND HUMANITIES

S. W. Austin, R. Becka, R. W. Burch, S. H. Daniel, M. M. Davenport, S. C. Hale, M. R. Hand, C. E. Harris, Jr., L. A. Hickman, A. Houtchens, J. L. Kvanvig, P. E. Lieuwen, H. J. McCann, Jr., J. J. McDermott, C. P. Menzel, W. G. Rose (Coordinator, Music), H. J. Saatkamp, Jr. (Head), D. J. Self, R. W. Stadelmann, P. B. Thompson

The Department of Philosophy and Humanities offers a master of arts degree in philosophy. This distinctive program emphasizes the application of philosophic inquiry to issues in medicine, engineering, business, agriculture, the military and other professions. A wide range of courses in the history of philosophy and its major areas provides the basis not only for this applied emphasis but also for further study in philosophy.

The M.A. program is intended to be flexible to support several types of interests. Individuals who would like to learn more about the philosophical principles of their chosen fields, or who may have come to the study of philosophy late in their undergraduate careers and who would like to continue such study, or who are returning to academic pursuits after several years will find this program particularly appealing.

Two options for obtaining the M.A. are available: a non-thesis internship option and a thesis option. Students interested in applying their philosophical skills in educational, medical, legal, agricultural, military, or business environments will participate in a professional internship in addition to taking 27 semester hours of course work (nine of which may be in other disciplines). Individuals who choose to write a master's thesis must take at least 24 semester hours (six of which may be in other disciplines) in addition to their thesis research. Depending on their background, applicants may be required to take particular undergraduate courses in order to enhance their graduate studies.

PHILOSOPHY
(PHIL)

601. Major Philosophical Issues. (3-0). Credit 3. Major philosophical theories as applied to selected problems and issues in such areas as art, education, politics and religion. Specific content and structure will be determined by interests and needs of students enrolled.

608. Philosophy of Education. (3-0). Credit 3. Major philosophical systems and their implications for the theory and practice of education.

671. Ethics for the Professional. (3-0). Credit 3. Basic concepts and theories underlying major contemporary ethical codes with application to ethical problems encountered in professions such as engineering, law, business and teaching.

685. Problems. Credit 1 to 3. Directed studies in specific problem areas in philosophy.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of philosophy. May be repeated for credit. Prerequisite: Approval of instructor.

HUMANITIES
(HUMA)

685. Problems. Credit 1 to 6. Directed studies in specific problem areas in the humanities. May be repeated for credit. Prerequisite: Approval of instructor.

MUSIC
(MUSC)

685. Problems. Credit 1 to 6. Directed studies in specific problem areas in music. May be repeated for credit. Prerequisite: Approval of instructor.

DEPARTMENT OF PHYSICS

T. W. Adair III, G. Agnolet, R. E. Allen, R. L. Arnowitt (Interim Head), W. H. Bassichis, R. A. Bryan, D. A. Church, R. B. Clark, T. M. Cormier, D. D. DiBitonto, M. J. Duff, N. M. Duller, Jr., D. J. Ernst, A. L. Ford, Jr.*, E. S. Fry*, C. A. Gagliardi, P. J. Green II, J. S. Ham, J. C. Hiebert, C.-R. Hu, F. R. Huson*, M. V. Jaric, G. W. Kattawar, R. A. Kenefick, W. P. Kirk, C.-M. Ko, E. Krotscheck, J. A. McIntyre, P. M. McIntyre, D. P. Nanopoulos, D. G. Naugle*, L. C. Northcliffe, C. N. Pope, J. F. Reading, J. H. Ross, W. M. Saslow, H. A. Schuessler, S. Shlomo, R. A. Smith, R. E. Tribble, R. C. Webb, M. B. Weimer, D. H. Youngblood

*Graduate Advisor

The physics curriculum provides classroom and research experience that prepares a graduate student for a career of either research and teaching at a university, or research and development at an industrial or government laboratory. The courses are well suited to graduate students in chemistry, mathematics, geosciences or engineering, as well as those seeking a graduate degree in physics.

PHYS 601, 603, 606, 607, 615 and 616 and/or courses in mathematics and research in the field of the thesis will normally comprise the program of a candidate for the degree of master of science. A non-thesis option is also offered. The six courses mentioned together with PHYS 611, 617, 624 and 625, provide a comprehensive, integrated coverage of the fields of classical and modern physics at the graduate level and constitute the basic courses normally required for the degree of doctor of philosophy. More advanced courses in a number of specialized fields are available for candidates for the Ph.D. degree. There is no language requirement for the Ph.D. degree. Satisfactory completion of a departmental qualification exam covering material from the first four M.S. courses is required for the continuation of the Ph.D. and is also part of the examination for the non-thesis M.S. degree.

As part of the training of the graduate student pursuing the M.S. or Ph.D. in physics, the Department of Physics requires all students to teach at least two semesters for the M.S. degree and at least four semesters for the Ph.D. degree.

The current research areas of members of the department include experimental and theoretical research in atomic, nuclear and low temperature/solid state physics. Other research areas within the department include the theory of elementary particle interactions, atmospheric physics and experimental high energy physics. Research laboratories supporting the experimental programs are well-equipped with modern research apparatus. Special support facilities include a helium liquefier, a VAX 11/782 computer system, and a variable energy cyclotron.

(PHYS)

601. Analytical Mechanics. (4-0). Credit 4. Lagrange, Hamilton and Hamilton-Jacobi equational approaches to dynamics; canonical transformation and variational techniques; central force and rigid body motions; the mechanics of small oscillations and continuous systems. Prerequisites: MATH 311 or 601, PHYS 303 or equivalents.

603. Electromagnetic Theory. (4-0). Credit 4. Boundary-value problems in electrostatics; basic magnetostatics; multipoles; elementary treatment of ponderable media; Maxwell's equations for time-varying fields; energy and momentum of electromagnetic field; Poynting's theorem; gauge transformations. Prerequisites: MATH 311 or 601, PHYS 304, or equivalents.

606. Quantum Mechanics. (4-0). Credit 4. Schrodinger wave equation, bound states of simple systems, collision theory, representation and expansion theory, matrix formulation, perturbation theory. Prerequisites: MATH 601, PHYS 412 or equivalents.

607. Statistical Mechanics. (4-0). Credit 4. Classical statistical mechanics, Maxwell-Boltzmann distribution, and equipartition theorem; quantum statistical mechanics, Bose-Einstein distribution and Fermi-Dirac distribution; applications such as polyatomic gases, blackbody radiation, free electron model for metals, Debye model of vibrations in solids, ideal quantum mechanical gases and Bose-Einstein condensation; if time permits, phase transitions and nonequilibrium statistical mechanics. Prerequisites: PHYS 408 and 412, or equivalents.

611. Electromagnetic Theory. (4-0). Credit 4. Continuation of PHYS 603. Propagation, reflection and refraction of electromagnetic waves; wave guides and cavities; interference and diffraction; simple radiating systems; dynamics of relativistic particles and fields; radiation by moving charges. Prerequisites: PHYS 603, MATH 602, or equivalents.

615. Methods of Theoretical Physics I. (3-0). Credit 3. Orthogonal eigenfunctions with operator and matrix methods applied to solutions of the differential and integral equations of mathematical physics. Contour integration, asymptotic expansions of Fourier transforms, the method of stationary phase and generalized functions applied to problems in quantum mechanics. Prerequisites: PHYS 412, 304; MATH 311, 312; or equivalents.

616. Methods of Theoretical Physics II. (3-0). Credit 3. Green's Functions and Sturm-Liouville theory applied to the differential equations of wave theory. Special functions of mathematical physics. Numerical techniques are introduced. Conformal mapping and the Schwarz-Christoffel transformation applied to two-dimensional electrostatics and hydrodynamics. Prerequisites: PHYS 412, 304; MATH 311, 312; or equivalents.

617. Physics of the Solid State. (3-0). Credit 3. Crystalline structure and symmetry operations; electronic properties in the free electron model with band effects included; lattice vibrations and phonons; thermal properties; additional topics selected by the instructor from: scattering of X-rays, electrons, and neutrons, electrical and thermal transport, magnetism, superconductivity, defects, semiconductor devices, dielectrics, optical properties. Prerequisites: PHYS 408 or 607 and 412 or 606 or equivalents.

624. Quantum Mechanics. (4-0). Credit 4. Continuation of PHYS 606. Scattering theory, second quantization, angular momentum theory, approximation methods, application to atomic and nuclear systems, semi-classical radiation theory. Prerequisite: PHYS 606 or equivalent.

625. Nuclear Physics. (3-0). Credit 3. Nuclear models, nuclear spectroscopy, nuclear reactions, electromagnetic properties of nuclei; topics of current interest. Prerequisite: PHYS 606 or equivalent.

627. Elementary Particle Physics. (3-0). Credit 3. Fundamentals of elementary particle physics. Particle classification, symmetry principles, relativistic kinematics and quark models. Basics of strong, electromagnetic and weak interactions. Prerequisite: PHYS 606.

631. Quantum Theory of Solids. (3-0). Credit 3. Second quantization, and topics such as plasmons; many-body effects for electrons; electron-phonon interaction; magnetism and magnons; other elementary excitations in solids; BCS theory of superconductivity; interactions of radiation with matter; transport theory in solids. Prerequisites: PHYS 617 and 624 or equivalents.

634. Relativistic Quantum Field Theory. (3-0). Credit 3. Classical scalar, vector and Dirac fields. Second quantization. Scattering matrix and perturbation theory. Dispersion relations. Renormalization. Prerequisite: PHYS 624 or equivalent.

635. Scattering Theory. (3-0). Credit 3. General time-dependent integral scattering solutions. Feynman diagrams. Optical theorem. Non-local potentials. Partial-wave scattering solutions. Unitarity. Effective range theory. Polarization phenomena. Prerequisite: PHYS 624 or equivalent.

636. The Many-Body Problem. (3-0). Credit 3. Second quantization; Green's functions; Feynman diagrams; Dyson's equations; Bethe-Salpeter equation; Hartree-Fock and random phase approximations; linear response theory, screening and correlation energy for the electron gas; nuclear matter; superconductivity; liquid ^{3}He and ^{4}He; the finite nucleus. Prerequisite: PHYS 624 or approval of instructor.

644. Low Temperature Physics. (3-0). Credit 3. Quantum behavior of matter at extremely low temperatures; production of low temperatures in the laboratory, superfluidity in ^{3}He and ^{4}He and magnetic properties. Prerequisites: PHYS 606, 607 and 617 or equivalents.

645. Nuclear Theory. (3-0). Credit 3. Topics of current interest; multipole theory of electromagnetic interaction, shell model and collective model of nucleus, and models of nuclear reactions. Prerequisites: PHYS 606 and 625 or equivalents.

647. Seminar in Atomic Physics. (3-0). Credit 3. Topics in contemporary physics presented with lectures and assignments based on current literature and review articles. Topics include research on time reversal; parity violations and QED effects; laser and synchrotron radiation spectroscopy; ion-atom charge transfer, excitation and coherence effects. May be taken three times for credit. Prerequisite: PHYS 606.

654. Low Temperature Physics. (3-0). Credit 3. Quantum behavior of matter at extremely low temperatures; thermal and electronic properties of solids; superconductivity. Prerequisites: PHYS 606, 607 and 617, or equivalents.

659. The Evolution of Physics. (2-2). Credit 3. Traces the evolution of classical physics from early Greek times through the end of the 19th century; feedback between ideas in physics and the surrounding culture. Laboratory techniques for teaching classical physical concepts.

660. Evolution of Physics. (2-2). Credit 3. Continuation of PHYS 659. Evolution of physics in the 20th century; birth and development of quantum physics, relativity and nuclear physics. Laboratory techniques for teaching modern physical concepts.

665. Concepts of Modern Physics. (3-0). Credit 3. Physical phenomena of contemporary interest; physical concepts. Cosmology and astrophysics, elementary particles, lasers and their applications, atomic and nuclear phenomena, and the application of physical principles in recent technology. Laboratory techniques for presenting the concepts in inquiry-oriented physical science courses.

666. Scientific Instrument Making. (2-2). Credit 3. Theory and techniques for designing and constructing advanced scientific instruments such as spectrometers, cryostats, vacuum systems, etc.; mechanical and electronic shop procedures utilizing the lathe and mill; welding and soldering; drafting and print reading; circuit design. May be taken twice for credit. Prerequisite: Approval of instructor.

667. Physics for Advanced Placement Teachers. Credit 1 to 4. A review of the fundamental concepts and techniques of physics and their use in the solution of physical problems. The course will cover topics included in Advanced Placement Physics Courses B and C; mechanics, electricity and magnetism, kinetic theory and thermodynamics, waves, optics and modern physics. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Subjects of current importance. Normally required of all graduate students in physics.

685. Problems. Credit 1 to 6 each semester. Individual problems not related to thesis. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of physics. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Physical Research. (3-0). Credit 3. Problems in the various specialized research areas of the department are presented and discussed in detail. Methods of solution together with applicable experimental design and theoretical techniques are discussed in detail. May be repeated for credit. Prerequisite: Baccalaureate degree in physics or approval of instructor.

691. Research. Credit 1 or more each semester. Research toward thesis or dissertation. Prerequisite: Baccalaureate degree in physics or equivalent.

695. Frontiers in Physics Research. (3-0). Credit 3. Present status of research in a variety of significant physical fields. Content will depend on the availability of visiting lecturers who will be selected because of distinguished international recognition in their fields of research. May be taken more than once but not to exceed 6 hours of credit toward a degree. Prerequisites: PHYS 601, 603, 606 and 607 or equivalents.

DEPARTMENT OF PLANT PATHOLOGY AND MICROBIOLOGY

D. N. Appel, A. A. Bell, N. E. Borlaug, J. A. Browning (Head), J. Craig, J. W. Dieckert, R. A. Frederiksen, C. F. Gonzalez, R. S. Halliwell, C. W. Horne, C. M. Kenerley, S. D. Lyda*, C. W. Magill, D. S. Marshall, R. D. Martyn, Jr., M. E. Miller, G. N. Odvody, R. E. Pettit, C. M. Rush, D. H. Smith, J. P. Stack, J. L. Starr, R. A. Taber, R. W. Toler, B. Villalon, N. G. Whitney

*Graduate Advisor

Members of the Department of Plant Pathology and Microbiology direct the master of science and doctor of philosophy degrees in genetics, plant breeding, plant pathology and plant physiology. Students carry out their thesis and dissertation research using facilities located on campus and/or at one of the research centers.

A competent command of the English language is required. For complete information on the options available, prospective students should contact the Department of Plant Pathology and Microbiology.

The department offers two options in its master of agriculture degree program: plant protection and plant sciences. The M.Agr. is a non-research professional degree which requires more formal course work in lieu of the thesis. This program emphasizes excellence in academic training and development of professional competence for students interested in careers in the agricultural industry, related biological-environmental agencies and industries and teaching. Professional internship opportunities are an integral part of the M.Agr. degree program.

PLANT PATHOLOGY
(PLPA)

Plant pathology is the science of plant diseases, their nature, causal agents and interrelated phenomena. The major objectives concern the scientific training of professional phytopathologists. Emphasis is placed on the fundamental and practical concepts associated with pathology and the conceptual schemes of fungal, bacterial, viral, nematological, mycoplasmal and physiogenic diseases. In addition, superior facilities are available for research in most phases including physiology of parasitism, host-parasite relationships, genetics of host resistance, genetics of pathogen variation and variability, genetics of host-pathogen-hyperparasite populations, ecology of soil-borne pathogens, etiology and epidemiology of plant diseases, nematology, virology, phytotherapeutics and clinical phytopathology.

601. Principles of Plant Pathology. (6-0). Credit 2. Major principles and concepts of plant pathology and their relationship to other agricultural sciences. To be taught on a 5-week basis. Prerequisites: An undergraduate course in microbiology and plant pathology and/or approval of instructor.

602. Fungi as Plant Pathogens. (3-6). Credit 2. Taxonomy, physiology and ecology of fungal pathogens; pathological considerations of disease development, inoculum production and dissemination, infection and host interactions; laboratory experience in isolation, quantification, inoculation and manipulation of fungal pathogens. To be taught on a 5-week basis. Prerequisite: PLPA 601 or approval of instructor.

603. Viruses as Plant Pathogens. (3-6). Credit 2. Fundamental and practical aspects of plant viruses, morphology, identification, biology and control methods. To be taught on a 5-week basis. Prerequisite: PLPA 601 or approval of instructor.

604. Bacterial Plant Pathogens. (3-6). Credit 2. Characterization of bacterial plant pathogens, their dissemination, host invasion, physiological influence on host and methods of control. To be taught on a 5-week basis. Prerequisite: PLPA 601 or approval of instructor.

605. Nematodes as Plant Pathogens. (3-6). Credit 2. An introduction to plant-parasitic nematodes. Emphasis on host/pathogen relationships; nematode ecology and epidemiological considerations; nematode management strategies. To be taught on a 5-week basis. Prerequisite: PLPA 601 or approval of instructor.

606. Plant Disease Management. (3-6). Credit 2. Current trends and practices in plant disease management; a practical experience with relevant apparatus; and a critique of a management system for a given crop. To be taught on a 5-week basis. Prerequisite: PLPA 601-605 or approval of instructor.

610. Host Plant Resistance. (3-0). Credit 3. Host plant resistance programs from the standpoint of the plant breeder, plant pathologist and entomologist. Team taught with each discipline represented. Roundtable discussions of assigned readings and lectures. Prerequisite: Approval of instructors. Cross-listed with ENTO 610 and AGRO 610.

616. Research Methods in Plant Pathology. (2-3). Credit 3. Standard principles, techniques and instruments used in plant pathology and microbiology investigations. Prerequisites: PLPA 301 and 303 or equivalents.

617. Principles and Concepts of Plant Pathogenesis. (3-3). Credit 4. Critical review of the literature on plant pathogenesis, specificity, mechanisms of host defenses and host-parasite interactions. Theoretical aspects of pathogenesis. Designed for the advanced student in plant pathology. Prerequisites: Graduate classification in Plant Pathology or approval of instructor.

618. Bacterial Plant Diseases. (2-3). Credit 3. Bacterial diseases of fruit and vegetable crops, field crops and ornamental plants; nature of the disease, dissemination of the pathogen and methods of control. Prerequisite: PLPA 601 or approval of instructor.

620. Plant Viruses. (2-3). Credit 3. Nature and properties of plant viruses and plant virus diseases. Prerequisite: PLPA 601 or approval of instructor.

621. Plant Parasitic Nematodes. (2-3). Credit 3. Morphology, identification and biology of plant parasitic and soil-borne nematodes; damage they cause; methods of control. Prerequisite: PLPA 601 or approval of instructor.

623. Diseases of Field Crops. (2-3). Credit 3. Fundamental and practical aspects of more important and representative diseases of field crops. Plant disease problems peculiar to extensive cultivation methods. Prerequisites: PLPA 301, 303.*

624. Diseases of Fruits, Vegetables and Ornamentals. (2-3). Credit 3. Important fruit, vegetable and ornamental diseases. Relationships between signs and symptoms used in identification of specific plant diseases. Prerequisites: PLPA 301 and 303 or equivalents.*

625. Plant Pathogenic Fungi. (2-4). Credit 4. Identification of fungi responsible for plant diseases. Representative pathogens used to illustrate principles used in differentiating species. Prerequisites: PLPA 301 and 303 and approval of instructor.*

626. Diagnosis of Plant Diseases. (1-3). Credit 2. Techniques employed in field diagnosis of plant diseases. Histological and microbiological studies to verify initial diagnosis. Prerequisites: PLPA 625 or approval of instructor.*

627. Theory of Plant Disease Epidemics. (2-3). Credit 3. Nature, scope, techniques and theoretical basis of quantitative plant disease epidemiology. Prerequisites: PLPA 606 or approval of instructor.

628. Biology of Soil-Borne Fungal Pathogens. (3-0). Credit 3. Current concepts of the life strategies of soil-borne fungal pathogens including survival, reproduction, dissemination, maintenance and infection; influence of soil physical environment; experimental approaches for researching soil-borne pathogens. Prerequisite: PLPA 601 or approval of instructor.

629. Diseases of Forest and Shade Trees. (2-3). Credit 3. The causes and controls for important tree diseases described; the nature of pathogenesis and host resistance in trees for selected biotic, abiotic and decline diseases; disease management in natural forest ecosystems, plantations and urban environments. Prerequisites: PLPA 301 and 303 or approval of instructor.*

681. Seminar. (1-0). Credit 1 each semester. Reports and discussions of topics of current interest in plant pathology; reviews of literature on selected subjects.

684. Professional Internship. Credit 1 to 4. Work-study program for on-the-job training. The student's major professor and job training supervisor will grade the individual. Prerequisite: Graduate classification in Department of Plant Pathology and Microbiology.

685. Problems. Credit 1 to 4 each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisite: PLPA 301 and 303 and approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of plant pathology. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Original investigations in support of thesis or dissertation.

*Field trip required for which departmental fee may be assessed to cover costs.

PLANT PHYSIOLOGY

S. R. Archer, J. B. Beard, C. R. Benedict, R. W. Bovey, D. D. Briske, B. G. Cobb, J. T. Cothren, H. T. Cralle, F. T. Davies, Jr., J. W. Dieckert, M. C. Drew, F. Fong, E. A. Funkhouser, J. W. Golden, S. S. Golden, L. R. Griffing, T. C. Hall, M. A. Hussey, W. R. Jordan, S. D. Lyda, G. G. McBee, K. J. McCree, T. D. McKnight, E. L. McWilliams, M. G. Merkle, R. E. Meyer, J. C. Miller, Jr., P. W. Morgan, J. E. Mullet, C. L. Nessler, R. J. Newton, W. D. Park, C. O. Patterson, J. C. Pommerville, D. W. Reed, P. J. Rizzo, P. J. H. Sharpe, J. D. Smith, R. H. Smith, E. J. Soltes, J. B. Storey, S. M. D. Rogers, T. L. Thomas, J. P. van Buijtenen, D. M. Vietor

The interdepartmental curriculum in plant physiology is administered by the faculty of plant physiology through the Department of Soil and Crop Sciences. Degree programs are available leading to M.S. and Ph.D. degrees. Program requirements are determined and supervised by the faculty of plant physiology. Degree programs are prepared on an individual basis by the graduate student's Advisory Committee. Students are housed, for administrative purposes, in the department of their major professors.

Plant physiology seeks to understand the functions and behavior of plants. It blends botany, chemistry, genetics and physics. Traditionally, plant physiologists have been interested in the improvement of agriculture, and many of the most basic findings on photoperiodism, mineral nutrition, plant growth regulators, morphogenesis and postharvest physiology have had major effects on modern agriculture. Today the unifying goal of plant physiology is to understand and improve plants. This goal involves significant interdisciplinary interactions with molecular genetics, plant breeding, environmental physics, agronomy and other plant-agriculture disciplines.

Graduate degree programs in plant physiology are individually designed to prepare graduates for careers in specialized areas of the discipline including molecular biology, metabolism, development, physiological ecology and environmental or crop physiology. Faculty members are housed in the Departments of Biochemistry and Biophysics, Biology, Forest Science, Horticultural Sciences, Industrial Engineering, Plant Pathology and Microbiology, Range Science and Soil and Crop Sciences; courses in these departments support the plant physiology curriculum along with those in chemistry, genetics, mathematics, physics and statistics.

All plant physiology graduate students participate in the student seminar program, the faculty-sponsored visiting scientist seminar program, other faculty-sponsored special programs, the core curriculum of plant physiology courses and regional and national scientific meetings. These activities lend continuity and unity to the graduate student group just as research topics and the selection of supporting courses lend diversity to individual programs.

(PPHY)

605. Plant Metabolism I. (3-0). Credit 3. Fundamental process of autotrophy; photosynthesis and nitrogen fixation in relation to plant physiology and crop productivity. Prerequisites: BICH 410; PPHY 313.

607. Physiology of the Fungi. (3-3). Credit 4. Physiological activities of fungi; growth and development, nutrition, intermediary metabolism, reproduction and physiology of parasitism. Prerequisite: BIOL 353 or approval of instructor. (Offered 1987-88 and alternate years thereafter.)

608. Current Research in Plant Cell Culture. (2-0). Credit 2. Current literature using plant cell culture, particularly as it relates to plant biotechnology and genetic engineering. Prerequisite: PPHY 313.

609. Quantitative Plant Physiology. (2-6). Credit 4. Methods employed in various types of physiological investigations and interpretation of results obtained by them. Prerequisite: PPHY 313 and 315.

611. Plant Nutrition. (3-0). Credit 3. Inorganic nutrition of plants; solute absorption, accumulation and translocation, growth in artificial media, physiological roles of various elements, and biochemical problems associated with salt absorption. Prerequisite: PPHY 313 or equivalent.

612. Phytohormones and Plant Growth Regulators. (3-0). Credit 3. Classification, properties and action of naturally occurring plant hormones as well as synthetic growth regulators and their practical application. Prerequisite: PPHY 313.

620. Experimental Techniques in Plant Physiology. (2-6). Credit 4. Instrumentation and techniques used in research on various physiological processes in plants, such as photosynthesis, carbon metabolism, metabolic enzymes, respiration, and plant growth and development. Prerequisites: PPHY 313, 315; BICH 410.

671. Plant Cell Biology. (4-0). Credit 1. Analysis of ultrastructure and function of plant cells. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

672. Environmental Physics and Crop Modeling. (4-0). Credit 1. Analysis of energy and mass exchanges between single leaves or plant canopies and the environment; the integration of these processes with physiologically based crop modeling. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

673. Environmental Mechanisms of Plant Growth. (4-0). Credit 1. Analysis of physical and molecular mechanisms of whole plant responses to environment. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

674. Biosynthetic Process in Plants. (4-0). Credit 1. Analysis of biosynthesis of cell walls, lipids, steroids, terpenoids and waxes. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

675. Photosynthesis and Photorespiration. (4-0). Credit 1. Analysis of the biochemistry and physiology of photosynthesis and photorespiration. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

676. Solute Transport and Utilization in Plants. (4-0). Credit 1. Analysis of inorganic nutrient uptake, long distance transportation and genetic control of nutrient acquisition. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

677. Plant Growth and Development. (4-0). Credit 1. Analysis of mechanisms of hormone action during vegetative and reproductive development, gene expression during development, photomorphogenesis and photoperiodism, dormancy and tropisms. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

678. Genetic Control of Physiological Processes. (4-0). Credit 1. Analysis of genetic control (structural and regulatory genes) of metabolic processes; genetically dissecting specific metabolic pathways and individual biochemical reactions, and determining how these are affected by specific enzymes, or sets of enzymes encoded in identifiable genes. Prerequisites: PPHY 313 and BICH 410 (or concurrent registration) or approval of instructor. (Four weeks).

681. Seminar. (1-0). Credit 1 each semester. Reports and discussions of topics of current interest in plant physiology; reviews of literature on selected subjects.

685. Problems. Credit 1 to 4 each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisite: PPHY 313.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of plant physiology. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Original investigations in support of thesis or dissertation.

DEPARTMENT OF POLITICAL SCIENCE

J. E. Anderson, J. A. Baer, F. R. Baumgartner, R. A. Bernstein, J. R. Bond, G. C. Casper, J. C. Clingermayer, J. A. Desveaux, A. DiQuattro, W. A. Dixon, J. A. Dyer, G. C. Edwards III, R. B. Flemming, M. W. Foley, A. T. Gadzey, G. M. Halter, R. E. Harmel, P. A. Hurley, C. A. Johnson, B. D. Jones (Head), W. Jones, Jr., W. Kim, J. E. Leighley, N. R. Luttbeg, A. Mintz, K. R. Mladenka, J. D. Nagler, E. B. Portis*, K. H. Ro, J. D. Robertson, H. J. Tucker, A. Vedlitz, R. J. Vichot, W. F. West, C. W. Wiggins**, B. D. Wood

*Graduate Advisor
**M.P.A. Program Coordinator

The Department of Political Science offers graduate study leading to the degrees of master of arts, master of public administration and the Doctor of Philosophy. The master of arts curriculum is appropriate as preparation for (1) a career in the public service, either political or administrative; (2) teaching at the secondary or community college level; or (3) more advanced work in political science or public administration. The master of public administration degree is based upon an interdisciplinary professional curriculum designed to provide broad preparation in public policy and administration for managerial careers in government and in industries with extensive relations with government. The Doctor of Philosophy degree is appropriate for those who wish to pursue careers as research scholars in academic, private or public organizations.

The M.P.A. degree program is described in another section of this catalog.

Requirements for an M.A. in political science may be satisfied by completing one of two options. Option I — the thesis plan — requires a minimum of 30 semester hours of credit, at least 24 of which must be for other than thesis research (POLS 691); a final oral examination is required unless the student has a 3.5 average or better. Option II — the non-thesis plan — requires at least 36 semester hours of course work, 24 of which must be in political science plus a minimum of six hours in a supporting field; a comprehensive examination is mandatory. Degree program formulation is the responsibility of the student, his or her graduate committee and the graduate advisor. Degree requirements are flexible within minimal constraints outlined in this catalog and department policies. Required courses for the M.A. in political science include a research methods sequence (POLS 601 and POLS 602). This sequence presumes familiarity with quantitative research methods in social science. Students without such preparation may be required to take prerequisite work in quantitative methods during their first semester of study in the program.

All students in the Ph.D. program are required to complete a common core of methodology courses, as well as a seminar in each of five fields of specialization: American politics, comparative politics, international relations, political theory and public administration/public policy. Additional courses are taken in three fields, one of which is designated as the student's major field. One of the remaining two fields may be from another discipline or interdisciplinary in nature.

Prospective students uncertain as to prerequisites or opportunities are encouraged to correspond with the graduate advisor before starting the admissions process.

(POLS)

601. Components of Political Inquiry. (2-2). Credit 3. The elements of empirical research design, techniques of data collection and data analysis. The evolution of political science as a scientific discipline. Prerequisite: Completion or concurrent enrollment in STAT 303 or equivalent. Required for political science majors.

602. Quantitative Political Analysis. (2-2). Credit 3. Theory, techniques and applications of quantitative analysis in political science. Prerequisite: POLS 601 or equivalent. Required for political science majors.

603. Quantitative Political Analysis II. (2-2). Credit 3. Introduction to advanced applications of quantitative analysis in political science; critical evaluation of the use of several advanced statistical techniques in political analysis. Prerequisite: POLS 602 or equivalent.

604. Conceptualization and Theory in Political Analysis. (3-0). Credit 3. Exploration of the function of general theoretical assumptions in social scientific research and a critical analysis of some of the most influential general conceptualizations of political phenomena. Prerequisite: POLS 601 or equivalent.

617. Intergovernmental Relations. (3-0). Credit 3. Relationships between various levels of government in the United States including the development of federalism, national-state-local and interstate relations, political and administrative actors and policy implementation through intergovernmental coordination. Prerequisite: Six hours of advanced social science or approval of instructor.

618. Urban Political Systems. (3-0). Credit 3. Urban politics, party structure and activities, voting behavior, power structures and current political problems.

619. Urban Government and Administration. (3-0). Credit 3. Selected problems in urban government, organization and administration.

620. Comparative Political Systems. (3-0). Credit 3. Comparative study of national political systems; cross-national relationships and comparative analysis.

621. Comparative Foreign Policies. (3-0). Credit 3. Major theoretical approaches to the study of foreign policy. Examines and compares the policies of several different types of states with the U.S.; internal and external factors which influence policies.

623. Seminar in Cross-National Topics. (3-0). Credit 3. Cross-cultural investigation of the manner in which selected political processes manifest themselves in various political systems. May be taken for credit up to 3 times as content varies.

624. Seminar in Regional Studies. (3-0). Credit 3. Political behavior or institutions within a specified country, region or cultural area. May be taken for credit up to 3 times as content varies.

625. Politics of the Soviet Union. (3-0). Credit 3. Politics, ideology and political development in the Soviet Union and its relations with communist satellite countries, major Western democracies and non-aligned nations.

630. International Politics. (3-0). Credit 3. Survey of international politics; security politics, the development of nations, international law, organization and integration.

633. Seminar in Foreign and Security Policy. (3-0). Credit 3. Selected aspects of the formation and conduct of foreign and defense policy. May be taken for credit up to 3 times as content varies.

634. National Security Policies. (3-0). Credit 3. Causes of war; arms control, national security, defense policies and related issues involved in war and peace among nations and political systems.

642. Seminar in Public Policy and Administration. (3-0). Credit 3. Literature and research problems of a selected aspect of public policy and administration. May be taken for credit up to 3 times as content varies.

643. Theory and Practice of Public Administration. (3-0). Credit 3. Theory, process and structure of management in the public sector. Internal management and behavior in federal, state or local agencies in a political setting.

645. Politics, Policy and Administration. (3-0). Credit 3. Relationship of politics and administration with reference to the influence of administration and bureaucracy, legislative bodies, parties, interest groups and other forces in the formation and execution of public policy in various levels of, primarily, American government.

646. Public Policy Theory. (3-0). Credit 3. Major theories and classifications of public policies, and general explanations of policy formation and impact; recent research testing major theories.

647. Public Policy Design and Evaluation. (3-0). Credit 3. Problems and methods in the design and evaluation of public policies and programs. Quantitative and qualitative approaches.

648. Public Personnel Administration. (3-0). Credit 3. Organization and operation of civil service personnel systems in American governments. Prerequisite: Six hours of advanced social science or management or approval of instructor.

649. Politics of the Budgetary Process. (3-0). Credit 3. Nature of public budgeting through focus on development of political and analytic theory and practice on budgetary processes, cycles and techniques at both national and sub-national levels of government. Prerequisite: Six hours of advanced social science or approval of instructor.

650. Introduction to Political Theory. (3-0). Credit 3. Examination of the most influential approaches, concepts and political arguments of classical and contemporary political theory.

656. Due Process of Law and Administrative Procedures. (3-0). Credit 3. Due process in a constitutional context as applied to administrative discretion and the theory and practice of public policy implementation. Administrative procedures are measured against the requirements of due process of law. Cross-listed with MGMT 656.

670. American Political Institutions. (3-0). Credit 3. Explores the major issues in the study of Congress, the presidency, the judiciary and the bureaucracy.

671. American Political Behavior. (3-0). Credit 3. An introduction to the core theories and controversies about American mass political behavior; topics include public opinion, political culture, political socialization, party identification and political participation.

672. Seminar in American Political Institutions. (3-0). Credit 3. Relevant literature and research problems of a selected aspect of American political institutions at the national level. May be taken for credit up to 3 times as content varies.

673. Seminar in American Subnational Politics. (3-0). Credit 3. Aspects of state, city or county government and intergovernmental affairs. May be taken for credit up to 3 times as content varies.

681. Seminar. (1-0). Credit 1. Topics of current research interest in political science with emphasis on promising areas of research opportunity. Prerequisite: Approval of graduate advisor.

684. Professional Internship. Credit 1 to 6. Directed internship in a public organization to provide on-the-job training with professionals in organizational settings appropriate to the student's professional objectives. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 6 each semester. Individual instruction in selected fields of political science. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of political science or public policy. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Thesis research. Credit will be given only upon acceptance of completed thesis. Prerequisite: Approval of graduate advisor.

DEPARTMENT OF POULTRY SCIENCE

C. A. Bailey*, C. R. Creger* (Head), J. H. Denton, R. C. Fanguy*, F. A. Gardner*, B. M. Hargis*, P. S. Hargis*, W. F. Krueger*, L. F. Kubena, D. B. Mellor*, T. W. Odom*, S. L. Pardue*, A. R. Sams*

*Graduate Advisor

Growth of the poultry industry and the need for a rapid expansion of scientific and technical knowledge in the various fields of science basic to a successful poultry business have supplied the motivation for the development of graduate courses in this phase of agriculture. In no field of agriculture is an understanding of the science and practice of nutrition, breeding, physiology, pathology, environmental physiology, processing, product development and marketing more necessary or more rewarding than in the modern intensive methods of producing poultry meat and eggs.

In offering graduate courses, the major objectives of the department are to offer training for work in industrial operations, teaching, research or extension; to bridge the gap in both directions between courses in fundamental biochemistry, genetics, physiology and economics and their practical application to the production of poultry and poultry products; and to give students planning to go into some productive phase of poultry science a more thorough scientific background of knowledge and approach to problems than is possible in an average four-year undergraduate curriculum.

The department offers graduate work leading to the master of agriculture, master of science and doctor of philosophy degrees. Faculty expertise exists for study in poultry genetics and breeding, poultry nutrition and feeding, avian physiology, environmental physiology, reproduction, game bird management, incubation, production and management, poultry processing and marketing, and poultry product development.

(POSC)

603. Avian Incubation and Embryology. (3-3). Credit 4. Embryonic development of bird eggs under both commercial and experimental incubation conditions. Developmental processes are evaluated relative to various environmental and genetic parameters. Prerequisite: Approval of instructor.

604. Trends in Poultry Technology and Management. (3-2). Credit 4. Intensive literature review and in-depth analysis of special topics in poultry science; may include advanced environmental physiology, endocrinology and reproduction, birds as models for biomedical research, efficiency economics, management innovations, etc. Summer topics include effective use of poultry in teaching, poultry projects and demonstrations, poultry oriented youth programs, recent advances in the industry, etc. Prerequisites: POSC 201, 425, or equivalent.

609. Avian Physiology. (3-3). Credit 4. Basic physiological principles pertaining specifically to avian species. Cardiovascular, neural, respiratory, digestive, endocrine and reproductive systems. Physiological experiments use various avian species as laboratory animals. Prerequisite: Approval of instructor.

611. Poultry Processing and Distribution Technology. (3-2). Credit 4. Poultry and egg composition, mechanisms of poultry and egg quality preservation, effects of storage environments, time and product treatment. Evaluation of commercial methods of product assembly, processing, distribution and quality control. Evaluation of physical, microbiological, functional and chemical methods of quality determination. Cross-listed with FSTC 611.

615. Avian Nutrition. (3-0). Credit 3. Metabolism and nutritional requirements of domestic fowl including proteins, carbohydrates, fats, minerals, vitamins and related feed additives. Prerequisites: CHEM 228 or 232; POSC 411 or approval of instructor.

625. Least-Cost Feed Formulation. (2-2). Credit 3. Theoretical and applied principles associated with least-cost feed formulation, ingredient inventory, farm and feed mill management. Computer optimization of resources for most efficient least-cost production with applications to all domestic farm animals. Applications of micro-computer technology. Prerequisites: POSC 411, ANSC 309.

640. Biomineralization in Animals. (3-0). Credit 3. Factors involved in the process of biomineralization; role of nutrients, physiological processes and environment in normal and abnormal biomineralization. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603. Cross-listed with NUTR 640.

645. Nutrition and Metabolism of Vitamins. (3-0). Credit 3. Chemistry and metabolism of the fat soluble and water soluble vitamins and their roles in animals; integrates cellular biochemistry and metabolism of the vitamins in the vertebrate animals. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603. Cross-listed with NUTR 645.

650. Nutrition and Metabolism of Minerals. (3-0). Credit 3. Nutritional significance of minerals in animal metabolism; chemical, biochemical and physiological role of minerals and homeostatic control in animal metabolism. Prerequisites: POSC 411 or ANSC 303; BICH 410 or 603. Cross-listed with NUTR 650.

681. Seminar. (1-0). Credit 1 each semester. Intensive review of literature on feeding, breeding, incubation, marketing, and management. Development of familiarity with journals, organizations, agencies and personnel working on poultry problems. May be repeated as many semesters as desired. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4. Work-study program, for students interested in a master of agriculture degree in avian science. Students expected to prepare a scholarly report acceptable to graduate committee.

685. Problems. Credit 1 to 6 each semester. Individual problems involving application of theory and practice in the various disciplines of poultry science. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of poultry science. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Research methods and techniques in breeding, nutrition, physiology, marketing, management and products technology. Students must conduct experiments in one of these fields. Design of experiments, collection, analysis and presentation of experimental data. Designed for thesis or dissertation credit.

DEPARTMENT OF PSYCHOLOGY

W. E. Arthur, Jr., L. T. Benjamin, Jr., A. E. Bourgeois, D. Carlson-Jones, A. J. Casey, T. A. Cavell, L. B. Christensen*, W. D. Crano, E. S. Davidson, D. Fallon, R. A. Finke, J. W. Grau, K. G. Hursey, J. M. Kern, A. D. LeUnes, C. J. Lutes, J. L. Mendoza, J. R. Nation, C. W. Parks, Jr., R. C. Prather, R. D. Pritchard, W. S. Rholes, D. H. Rosen, C. D. Samuelson, J. E. Sawyer, S. Schenk, W. Shebilske, L. C. Shine II, J. A. Simpson, S. M. Smith, B. H. Stagner, W. E. Stock, J. Vaid, T. B. Ward, P. J. Wellman, D. J. Woehr, W. Wood, D. J. Woods, S. Worchel (Head)

*Graduate Advisor

The Department of Psychology offers graduate study leading to a Ph.D. degree in psychology. Students in the doctoral program may enter the General Psychology, Clinical/Community, or Industrial/Organizational Option. Students in the general psychology track will take a broad range of courses before focusing research efforts in one of the many areas of expertise offered by the faculty. The general psychology track offers both a basic and applied science focus and allows students a great deal of flexibility in designing a course of study to fit their needs. Research concentrations exist in behavioral, neuroscience, cognitive psychology, developmental psychology and social psychology. This option allows students the opportunity to prepare for careers in academics or in applied settings. The Clinical/Community Option offers students specialized training in the area of clinical psychology. In addition to course work and research, students in this option will have at least three semesters of practicum experience in which they have supervised training in a mental health setting. This course of study also involves a one-year internship. Students in the Industrial/Organizational Option will receive specialized training to prepare them to work in business, consulting, governmental or academic settings. In addition to research and course work, students in this option will be encouraged to take practicums where they receive supervised training in an organizational setting. Students in all the options will earn their M.S. degree before beginning work on their Ph.D. degree. The graduate program in psychology is strongly research oriented, and all students are expected to become involved with research beginning in their first year.

(PSYC)

603. Motivation and Cognitive Processes. (3-0). Credit 3. Selected topics in areas of motivation and higher mental processes; symbolic processes in perceptual organization; learning and remembering, reasoning and creativity.

604. Personality and Social Behavior. (3-0). Credit 3. Advanced seminar focusing on special topics; interaction of personality and situational determinants of behavior. Prerequisite: PSYC 330 or 315.

605. Clinical Psychology. (3-0). Credit 3. Survey of clinical psychology; therapeutic modalities; experimental study of disordered behavior; diagnostic constructs and the assessment process; social, political and ethical contexts of mental health service delivery. Prerequisite: PSYC 306 and approval of instructor.

606. Classical Conditioning and Instrumental Learning. (3-0). Credit 3. Procedural and theoretical issues in Pavlovian and discrete trials conditioning; methods by which basic principles identified in these areas may be applied to contemporary social problems. Prerequisite: PSYC 340 or approval of department head.

607. Experimental Psychology. (2-3). Credit 3. Experimental methods; developing a general frame of reference for approaching experimental research problems.

608. Introduction to Clinical Skills. (3-0). Credit 3. Ethical and legal issues in clinical practice; development of listening and interpretation skills; supervised practicum in interviewing a normal subject; structured role-play of clinical situations. Prerequisite: Approval of instructor.

609. Psychophysiology. (2-3). Credit 3. Current research and methodological procedures on physiological bases of sensation-perception, memory and learning, arousal-sleep-attention, emotions and motivation. Prerequisite: PSYC 335.

610. Organizational Psychology. (3-0). Credit 3. Current literature and research in employee motivation, satisfaction, leadership, communication, group conflict and other group processes.

611. Personnel Psychology. (3-0). Credit 3. Application of psychological principles and research methods to the areas of selection, placement, job analysis, performance appraisal and training. Prerequisites: Graduate classification; PSYC 351 or equivalent or approval of instructor.

612. Behavior Modification. (3-0). Credit 3. Principles of behavior theory and techniques of application to pathological and deviant behaviors. Prerequisite: PSYC 340 or approval of department head.

614. Practicum in Psychology. Credit 1 to 4 each semester. Practical on-the-job experience for graduate students. Activities will be guided by psychologists in the following areas: behavior modification, social, clinical, experimental and industrial. Supervision will be provided by members of university staff. May be taken more than once but not to exceed 18 hours of credit toward a graduate degree. Prerequisite: Approval of department head.

615. Perceptual Processes. (3-0). Credit 3. Complex sensory and perceptual phenomena with emphasis on the relationship between perception and motivation, cognition, creativity and instinctive/ethological; learning/experiential factors in higher level perceptual processes.

616. Modifying Problem Behavior. (3-0). Credit 3. Principles and techniques of modifying aggressive, disruptive, hyperactive, underachieving and other problem behaviors in natural settings; behavior of children and adolescents at home, school and at play. Prerequisite: Course in psychology of learning or behavior principles or approval of department head.

617. Analytical Psychology. (3-0). Credit 3. Survey emphasizing Jungian psychology but including coverage of Freudian psychology; application of analytical principles and concepts to a variety of clinical issues and situations. Prerequisite: PSYC 605 or approval of instructor.

618. Psychology of Persuasion. (3-0). Credit 3. Theory and scientific evidence regarding strategies and tactics of persuasion; explores theoretical controversies and presents potential integrations.

619. History and Systems of Psychology. (3-0). Credit 3. Historical examination of scientific psychology's antecedents in philosophy and physiology; early systems of psychology including structuralism, functionalism, behaviorism, Gestalt psychology and psychoanalysis. Prerequisite: Graduate classification.

620. Theories of Social Psychology. (3-0). Credit 3. Current theories of social psychology and a review of related studies to these theories. Theories of attitude change, prosocial behavior, aggression, equity, coalition formation, social learning and S-R theory applied to social behavior. Prerequisites: PSYC 315; SOCI 411.

621. Seminar in Social Psychology. (3-0). Credit 3. Attitudes and persuasion; small group interaction and performance; prosocial behavior; aggression; self concept; applied social problems; gender differences in social interaction; and social cognition. May be repeated up to three times for credit. Prerequisite: Approval of instructor.

622. Program Evaluation. (3-0). Credit 3. Survey of the purpose, practice, and application of evaluation research; program planning, needs assessment, measurement, process and outcome evaluations, communication of results. Prerequisite: PSYC 671 or equivalent or approval of instructor.

623. Standardized Tests and Measurements. (3-0). Credit 3. Principles of psychological testing. Uses and critical evaluation of tests of achievement, intelligence, aptitude and personality.

624. Individual Testing. (2-3). Credit 3. Practicum in administration and interpretation of Stanford-Binet and Wechsler-Bellevue intelligence tests. Introduction to individual tests of personality. Prerequisite: PSYC 623 or registration therein.

625. Introduction to Projective Methods. (2-3). Credit 3. Theory and application of projective methods. Historical background of projective theory and applications. Practical application of Rorschach and other tests. Prerequisites: PSYC 623, EPSY 622 or approval of instructor.

626. Psychopathology. (3-0). Credit 3. Various symptom categories in psychopathology including differing theoretical conceptualizations of these symptom categories, and theories and research concerning etiology and treatment.

628. Behavior Disorders in Children. (3-0). Credit 3. Different systems of classification including research and theory about the origins and anticipated outcomes of various emotional disorders. Families of disturbed children. Major treatment approaches and community resources for intervention. Prerequisites: Graduate classification; PSYC 407 or equivalent or approval of instructor.

629. Seminar in Clinical/Community Psychology. (3-0). Credit 3. Assessment and treatment of specific clinical disorders such as depression, sexual dysfunctions and deviations, anxiety-based disorders, autism, marital distress and psychophysiological disorders. May be repeated up to three times for credit. Prerequisites: PSYC 605, 626, and 623 or equivalent.

634. Principles of Human Development. (3-0). Credit 3. Biological, psychological and cultural interrelationships in human development. Principles and methods as illustrated in research and theoretical contributions. Experiences in procedures of child study. Prerequisite: Graduate classification.

635. The Psychology of Aging. (3-0). Credit 3. Personality, cognitive, social and biological factors relevant to human aging; investigation of the validity of various stereotypes of the aged. Psychological impact of various social policies. Prerequisite: Approval of instructor.

636. Seminar in Developmental Psychology. (3-0). Credit 3. Cognitive development; social and emotional development; developmental abnormalities in connection with social/emotional and cognitive development; language acquisition; family processes; and development during infancy; recent developments in these fields. Topics will vary from semester to semester; may be repeated for credit up to three times as topics change. Prerequisite: Graduate classification.

640. Applied Physiological Psychology. (3-0). Credit 3. Principles of physiological psychology applied to situations encountered by practicing psychologists, introductory physiological information integrated with content on psychopharmacology, biochemical aspects of mental disorders, neurological indices of cerebral damage, biofeedback and stress. Prerequisite: Graduate classification.

671. Experimental Design for Behavioral Scientists. (2-3). Credit 3. Intensive practical study of designs of special interest to behavioral scientists. Repeated measures designs. Prerequisites: STAT 652 or equivalent.

672. Factor Analysis for Behavioral Scientists. (2-3). Credit 3. Principles and uses of Factor Analysis in behavioral research. Implementation, alternate factor models and interpretation with heavy use of numerical examples. Prerequisite: PSYC 671 or approval of instructor.

678. Marital Therapy. (3-0). Credit 3. Theory and practice of marital therapy emphasizing systems and communication approaches; effective strategies and techniques; therapy with specific marital problems and obstacles to effective therapy. Prerequisites: CPSY 631 and 639 or equivalent. Cross-listed with CPSY 678.

680. Seminar in Organizational Psychology. (3-0). Credit 3. Areas of organizational psychology: job stress, socialization processes, motivation, leadership, person perception in organizations, conflict management. May be taken more than once but not to exceed 15 hours of credit toward a graduate degree. Prerequisite: PSYC 610 or approval of instructor.

682. Seminar in Personnel Selection and Placement. (3-0). Credit 3. Personnel selection and placement including job analysis and evaluation, psychological testing, test development, psychometric theory, theories of test fairness, validity generalization, utility theory, performance appraisal and selection/placement decision models; may be repeated up to three times for credit; content will vary by semester. Prerequisite: PSYC 611 or approval of instructor.

684. Professional Internship. Credit 1 to 9 each semester. Full-time clinical experience in a departmentally-approved internship training facility. Limited to advanced doctoral students specializing in clinical psychology. Repeatable to 24 hours total. The 24 hours required for this course are in addition to the 96 hours required for the Ph.D. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problem in psychology or special topics to fit small group requirements. Prerequisite: Approval of department head.

689. Special Topics In . . . Credit 1 to 4. Selected topics in an identified area of psychology. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. Research for thesis.

697. Seminar in the Teaching of Introductory Psychology. (3-0). Credit 3. Introductory methods relevant to teaching psychology; for graduate students assisting in the teaching of PSYC 107. Prerequisite: Graduate classification.

DEPARTMENT OF RANGE SCIENCE

S. R. Archer, T. W. Boutton, R. W. Bovey, D. D. Briske, J. R. Conner, J. D. Dodd, W. T. Hamilton, S. L. Hatch, R. Heitschmidt, J. E. Huston, P. W. Jacoby, Jr., R. W. Knight, M. M. Kothmann, R. Q. Landers, Jr., D. K. Loh, R. E. Meyer, M. K. Owens, B. J. Ragsdale, J. L. Schuster* (Head), F. E. Smeins, J. W. Stuth, C. A. Taylor, Jr., T. L. Thurow, D. N. Ueckert, J. W. Webb, T. G. Welch, S. G. Whisenant, L. D. White

*Graduate Advisor

Graduate studies lead to the M.Agr., M.S. and Ph.D. degrees in range science. The M.Agr. and M.S.-nonthesis degrees are professional (nonresearch) programs providing advanced instruction on the management of rangeland resources. The M.S.-thesis and Ph.D. degrees place emphasis upon fundamental research into the structure, function and integrated management of rangeland resources.

The M.Agr. degree program is designed to give students broad academic training combined with practical experience to develop management skills. The program includes an internship of work on a rangeland resource or in the range-livestock industry, and emphasizes a diversified, multidisciplinary set of courses involving faculty with both scientific and industry experience.

Facilities and equipment are available for advanced instruction and student research in all phases of range science. Field sites and facilities are available throughout Texas for the study of biosystematics, range animal and plant nutrition, watershed management, range ecology, remote sensing, resource management, and range weed and woody plant control. The department has a strong program in knowledge engineering including the development of expert systems and simulation modeling for range ecosystems.

Graduate courses are designed to develop the academic skills of individuals and to advance their knowledge in the professional field of range science and supporting disciplines. Departmental seminars supplement the individual counseling of graduate students and serve to relate the most recent research findings applicable to the discipline. Individually planned graduate programs assure a sound education for each candidate.

Students in the Department of Range Science are required to have adequate preparation in rangeland resource management as well as in the fundamentals of such supporting fields as animal science, terrestrial ecology, economics, soil science and wildlife science. There is no foreign language requirement for the Ph.D. degree in range science.

(RASC)

601. Rangeland Resource Management. (3-0). Credit 3. Basic concepts and theories of rangeland resource management. Trends in range classification, grazing management and improvement practices. Prerequisite: Graduate classification in agriculture or related subject matter areas.

602. Ecology and Land Uses. (3-0). Credit 3. Ecological foundations for sustained use of natural resources. Climatic, edaphic, biotic and cultural factors in land resource allocation. Land and cover viewed with respect to population dynamics, succession and climax, gradients and graduation, equilibria and imbalance. Prerequisite: Graduation classification in agriculture or in allied subject.*

603. Range and Forest Watershed Management. (3-0). Credit 3. Management of range and forest watersheds; influence of range and forest practices on runoff, interception, infiltration, erosion and water quality. Current literature and research advances.*

604. Grazing Management and Range Nutrition. (3-0). Credit 3. Relationships between vegetation and grazing animals (domestic and wild) including the response of vegetation to grazing and the grazing process. Animal response to various grazing management practices and factors affecting diet selection, quality and intake on rangelands. Prerequisite: RASC 314 or 601.*

605. Range Research Methods. (3-0). Credit 3. Methods applicable to research on rangeland and related resources. Development of field research projects, study design and implementation techniques for vegetation evaluation, research project management and publication. Prerequisite: Graduate classification.

606. Range Economics. (3-0). Credit 3. Application of economic and financial tools for improved managerial decision-making in the range-livestock industry. Prerequisite: AGEC 325 or equivalent. Cross-listed with AGEC 606.

607. Range Plant Ecophysiology. (3-0). Credit 3. Influence of environmental parameters on plant growth and function and the morphological and physiological adaptations of plants to these parameters under rangeland conditions. Radiation budgets, carbon assimilation, water relations, temperature, mineral nutrition and selected biotic interactions. Prerequisite: RENR 205 or equivalent.

609. Plant and Range Ecology. (3-0). Credit 3. Plant communities, successions and effect of various degrees of use on vegetation types and edaphic factors. Prerequisite: RENR 205, 215 or equivalent.*

610. Range Grasses and Grasslands. (2-3). Credit 3. Basic concepts of grass structure and classification, recent advances in agrostological research, genetical and ecological basis for patterns of variation and evolution in grasses.*

613. Analysis of Natural Resource Systems. (3-2). Credit 4. Structure and function of general systems with emphasis on ecosystems. Application of computer techniques in the analyses and simulation of ecosystems. Prerequisite: MATH 230, RASC 417, STAT 652 or equivalents.

614. Advances in Range Improvement Practices. (3-0). Credit 3. Principles and recent advances in brush and weed control with mechanical, chemical, burning and biological methods; interrelationships of brush management with grazing, wildlife and watershed management; planning and economic analysis of range improvement practices.*

615. Rangeland Managerial Analysis. (3-0). Credit 3. Ranch management processes in planning and application of alternative land use schemes and multiple resource uses. Rangeland inventory and analysis, land use conversions, integrated resource uses and grazing management, economic analysis and decision-making. Prerequisite: RASC 314 or approval of instructor.*

616. Fire and Natural Resources Management. (2-3). Credit 3. Behavior and use of fire in the management of natural resources; principles underlying the role of weather, fuel characteristics and physical features of the environment related to development and implementation of fire plans. Prerequisites: Graduate classification and approval of instructor.

618. Rehabilitation of Disturbed Rangelands. (3-0). Credit 3. Principles related to rehabilitating disturbed rangelands for optimum use with minimal environmental impacts; site and plant species selection; surface modification and stabilization, and surface water modeling in relation to watershed protection and vegetation establishment. Prerequisite: Graduate classification.

619. Ecology of Shrubs and Shrublands. (3-0). Credit 3. Structure and function of shrub-dominated landscapes in arid and semi-arid regions are examined; physiological ecology and population biology of key species are discussed and related to community succession, stability, resilience and grassland to shrubland conversion; current literature will be emphasized. Prerequisite: RENR 205 or equivalent.

620. Rangeland Herbivory. (3-0). Credit 3. Examines the developmental morphology of range plants, morphological and physiological responses of individual plants to herbivory, and mechanisms which confer herbivory resistance; vegetation responses to mammalian herbivores evaluated within the context of the population and community levels of vegetation organization. Prerequisite: RENR 205 or equivalent.

681. Seminar. (1-0). Credit 1 each semester. Current scientific work in range management and related subjects in American and foreign fields. Prerequisite: Majors and minors in range science.

684. Professional Internship. Credit 1 to 4. Work study program for on-the-job training in master of agriculture program in range science. Prerequisite: Master of agriculture candidate in range science.

685. Problems. Credit 1 to 4 each semester. Investigations not included in student's research for thesis or dissertation. Lectures, conferences, field work, reports. Prerequisite: Graduate majors or minors in range science.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of range science. May be repeated for credit. Prerequisite: Graduate classification in range science or allied field.

691. Research. Credit 1 or more each semester. Research for thesis or dissertation. Prerequisite: Graduate majors in range science.

*Field trips required for which departmental fees may be assessed to cover costs.

READING

(See Educational Curriculum and Instruction)

DEPARTMENT OF RECREATION AND PARKS

D. E. Albrecht, T. W. Blaine, T. M. Bonnicksen (Head), J. L. Crompton, J. T. Diamond, J. H. Gramann, C. A. Gunn, E. H. Heath, L. Hodges, R. A. Kaiser, L. M. Reid, W. P. Stewart, J. R. Stoll, C. S. Van Doren*, T. Var

*Graduate Advisor

Graduate course offerings in the Department of Recreation and Parks are designed to provide scientific approaches to problems encountered in recreation, park and tourism management. The focus of the program is on the relationships between people, developments and the resource base. Special emphasis is placed on concepts and methods associated with the planning and administration of recreation, park and tourism areas, including studies in recreation and tourism systems planning, user preferences and behavior, economics, administration and systems analysis.

Graduate study in recreation and tourism is interdisciplinary. Cooperative relationships exist with a large number of outstanding graduate-level programs in the University. This provides students with an opportunity to structure an individualized degree program in the field of his or her choice. Courses selected within the department and in supporting fields are designed to serve the individual needs of students interested in teaching, public service, research, administration or the management of recreation, park and tourism developments. Specializations include systems planning, outdoor recreation, travel and tourism, economics and finance, administration and policy, resource sociology, and microcomputer applications.

The Department of Recreation and Parks offers courses of study leading to the master of agriculture, master of science and doctor of philosophy degrees in recreation and resources development, and an interdisciplinary master of agriculture degree in natural resources development. The M.Agr. program emphasizes professional involvement. Though equally as rigorous, this program differs significantly from the traditional M.S. degree. Additional courses in the student's selected field are included. Instead of a thesis, completion of a professional internship of at least six

months duration in an organization or agency related to the degree emphasis and submission of two professional papers on aspects of the internship experience are required. Agency and industry response to the M.Agr. program has been excellent.

The Department of Recreation and Parks does not require a foreign language in its Ph.D. degree programs. A foreign language is recommended, but not required, in travel and tourism curricula. The decision regarding the appropriateness of competence in a foreign language is determined by each student's graduate Advisory Committee within guidelines adopted by the department. Information on this subject is available on request from the department.

(REPK)

601. Recreation and Leisure Concepts. (3-0). Credit 3. History and philosophy of the field of recreation and parks; fundamentals of planning, development and management of resources allocated for recreation, parks and tourism purposes. Development of the recreation movement with broad treatment of the role of recreation and parks in contemporary society.

602. Conceptual Foundations of Recreation and Resource Development. (3-0). Credit 3. Sociological and social psychological dimensions of leisure, recreation and related behavior. Nature and function of leisure for individuals and for society; implications for development and management of recreation resources. Prerequisite: REPK 601 or previous academic background in recreation and parks.

603. Recreational Organization and Policy. (3-0). Credit 3. Executive leadership in park departments and recreation agencies; administration of recreation resources to meet human needs, decision-making and the structure of organizational goals.

605. Decision-Making in Recreation Administration. (3-0). Credit 3. Political and economic realities associated with policy and decision-making in resource allocation. Using game-simulation techniques as a predictive tool, specific problems are examined and alternative decisions evaluated.

607. Recreation and Park Design. (2-3). Credit 3. Fundamentals of the recreation planning process; historical perspective and objectives of planning; planning models; major component analysis including public involvement, resource evaluation, demand analysis, classification systems and standards, integral implementation and planning research needs.*

609. Socio-Economic Issues in Outdoor Recreation. (3-0). Credit 3. Socio-economic characteristics impinging on provision of outdoor recreation opportunities in urban and nonurban settings. Implications of economic factors to demand estimation, valuation, costs and repayment, financing, natural resource allocation, public-private sector interactions and policy issues.

611. Recreation Systems Planning. (2-3). Credit 3. Components of the tourism-park-recreation development system and the concepts of planning resource use at the larger-than-site scale. Physical and program factors important to development for visitor use. Computer techniques for land assessment.

615. Analytical Techniques in Recreation. (3-0). Credit 3. Analysis of current research; instruments and adaptive techniques used in the selection and formulation of research problems.

622. Recreational Resource Communication. (2-3). Credit 3. Philosophies, concepts and techniques associated with communication and dissemination of information pertaining to use of natural resources for recreation.*

636. Travel and Tourism. (3-0). Credit 3. Tourism and recreational travel; origins, present characteristics and societal impacts; implication of non-business travel in the U.S. and the emerging importance of international recreation.

650. Recreation Resource Development. (3-0). Credit 3. Theory of resource planning and development and of the role and significance of recreation and tourism in the broader environmental context; evaluation of relevant current and previous action programs in this country and elsewhere. Prerequisite: REPK 603 or approval of instructor.*

655. Recreation and Sports Law. (3-0). Credit 3. Legal principles affecting sponsors and users of recreation, parks and sports programs; liability concepts in tort, contract, civil rights and property law in program planning, development and management. Prerequisite: REPK 609 or approval of instructor. Cross-listed with PHED 655.

660. Environmental Impact Analysis for Parks and Recreation. (3-0). Credit 3. Analysis and critique of contemporary environmental analysis methods in current use; environmental impact statements. National policies; political, social and legal ramifications as related to recreation development.

666. Recreation Development in the Coastal Zone. (3-0). Credit 3. Specific recreational problems associated with coastal zone management. Nature, extent, location and value of coastal recreation behavior and relationship to the overall coastal framework. Implications for other areas of outdoor recreation resources management.

681. Seminar. (1-0). Credit 1. Preparation and discussion by students of special reports, topics and research data in recreation and parks. Presentation of subjects of professional significance by staff members and invited speakers.

684. Professional Internship. Credit 1 to 4. Survey and application of principles of recreation and resources development. Studies of selected aspects of park and recreation management in professional setting within an approved recreation/park agency under the supervision of a member of the graduate faculty. Required of all students in the master of agriculture degree program.

685. Problems. Credit 1 to 4 each semester. Investigations not included in student's research for thesis or dissertation. Problems selected in administration or management, recreation or planning.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of recreation and resources development. May be repeated for credit. Prerequisite: Approval of department head.

690. Theory of Research in Recreation and Resources Development. (3-0). Credit 3. Theory and design of problems and experiments in various subfields of recreation and resources development. Communication of research proposals and results. Evaluation of current research of faculty and students and review of current literature.

691. Research. Credit 1 or more each semester. Research in recreation and resources development for thesis or dissertation.

*Field trip required for which departmental fee may be assessed to cover costs.

RENEWABLE NATURAL RESOURCES

The graduate courses in renewable natural resources are designed to fit the needs of outstanding master of agriculture, master of science and Ph.D. students who wish to take interdisciplinary course work in natural resources with emphasis on coastal zone and water resources. All faculty members for these courses are regular faculty in the departments that comprise the Institute of Renewable Natural Resources. These courses stress a comprehensive understanding of the nature, use and management of marine environments, major issues in water and coastal zone resource management as well as the legal system's impact on management and development of water resources in the United States. Students in a variety of disciplines including agricultural economics, forest science, geography, geology, oceanography, range science, recreation and parks and wildlife and fisheries sciences may find these courses applicable to their degree plans, subject to Office of Graduate Studies regulations and the approval of their graduate committees.

(RENR)

661. Marine Resources Management. (3-0). Credit 3. Nature, use and management of the marine environment and its resources; study of major marine resources and uses; analysis of disciplinary contributions in understanding ocean resource problems; evaluation of major problems in managing common property resources. Prerequisite: Graduate classification.

662. Water Resources Law. (3-0). Credit 3. Legal system's impact on the management and development of water resources in the United States with special reference to Texas water law; relation of federal and state laws to water use for agriculture, industrial, commercial, recreational, marine and urban purposes. Prerequisite: Graduate classification.

664. Coastal Zone Management. (3-0). Credit 3. Major issues of coastal management in the United States; relationships between natural environments of the coastal zone and public policies affecting the development, use and conservation of natural resources. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of renewable natural resources. May be repeated for credit.

SAFETY EDUCATION
(See Industrial, Vocational and Technical Education)

SAFETY ENGINEERING
(See Industrial Engineering)

SCHOOL PSYCHOLOGY
(See Educational Psychology)

DEPARTMENT OF SOCIOLOGY

B. E. Aguirre, J. P. Alston, J. S. Burk, J. H. Copp, B. M. Crouch, B. A. Finlay, H. Fukurai, J. C. Gaston, C. O. Herring, H. B. Kaplan, V. M. Keith, W. P. Kuvlesky, E. Maret, W. A. McIntosh*, S. H. Murdock, R. Saenz, A. Schaffer, R. Schaffer, J. Sell*, G. E. Thomas, N. Williams, K. R. Wilson, F. D. Wolinsky, M. Zey (Head)

*Graduate Advisor

Graduates from accredited universities who meet the requirements of the Department of Sociology and the Office of Graduate Studies may work toward the following advanced degrees: master of agriculture in rural sociology, master of science in sociology and doctor of philosophy in sociology.

Students with degrees in fields other than sociology may be admitted provisionally at the master's degree level but will normally be required to make up deficiencies. Students at the Ph.D. level will normally be expected to have an advanced degree in sociology or take appropriate prerequisite courses in sociology.

Substantive areas of concentration in the department are Health and Aging Studies, Race and Ethnic Studies, Studies in Complex Organizations, the Sociology of the Family, and Rural Sociology. In addition to courses in these areas the department offers graduate courses in social organization, social stratification, social change, demography, sociological theory, social psychology, deviance, community, urban sociology, the sociology of education, and research methodology.

A wide variety of research programs in the department affords the student wide choice in research for a thesis or dissertation. To aid in financing graduate education, teaching and research assistantships and fellowships are available.

(SOCI)

601. Urban Sociology. (3-0). Credit 3. Patterns of organization and the dynamics of change in the contemporary city. Internal and external structure of the city; processes of growth and decline. Prerequisite: SOCI 321 or approval of instructor.

602. Rural Sociology. (3-0). Credit 3. Application of sociological concepts to the rural environment. Social change and its effect on rural social structures. Prerequisite: Approval of instructor.

603. The Contemporary Family. (3-0). Credit 3. Review and criticism of theories developed for study of the family. Family formation, dynamics, conflicts, power, dissolution; subcultural family forms and responses to social change.

604. Social Gerontology. (3-0). Credit 3. Special phenomena of old age; social roles and adjustment to problems of aging and the aged in American society.

608. Social Organization. (3-0). Credit 3. Theoretical and conceptual bases of patterned human behavior. Structural, processual and functional aspects of human groups from simplest informal to the most complex formal types: small groups, associations, institutions, complex organizations, bureaucracies, societies.

609. Social Change. (3-0). Credit 3. Concepts, theories and methodological approaches to studying social change. Evolutionary, conflict, equilibrium and modernization approaches. Prerequisite: Approval of instructor.

610. Sociological Theory. (3-0). Credit 3. Trends in theory-development in sociology; comparative study of general sociological frameworks and application of these systems to particular substantive areas of sociology. Prerequisite: SOCI 611.

611. Classical Sociological Theory. (3-0). Credit 3. Critical analysis of the writings of the principal founders of modern sociology; Marx, Durkheim and Weber and their influence on current theoretical issues. Prerequisite: SOCI 430, the equivalent, or approval of instructor.

612. The Community. (3-0). Credit 3. Problems, processes and techniques of community development. Effective methods through community development for improving the general well-being of community residents. Prerequisite: Twelve hours of social science.

613. Seminar in Sociological Theory I. (3-0). Credit 3. Contemporary theory. Structural-functionalism, system theory and symbolic interactionism; domain of each for sociological research; issues raised by respective partisans and critics. Prerequisite: SOCI 611 or equivalent.

614. Seminar in Sociological Theory II. (3-0). Credit 3. Contemporary theory. Critical analysis of theoretical systems and models used in sociology. Major metatheoretical approaches in sociology and more limited models and schema. Prerequisite: SOCI 613.

617. Comparative Ethnic Relations. (3-0). Credit 3. Cross-cultural variations in ethnic relations and structures of inequality; assessment of systems and power-conflict theoretical frameworks in diverse settings such as South America, Mexico, South Africa, Caribbean Regions and United States. Prerequisite: Approval of instructor.

618. Sociology of Education. (3-0). Credit 3. The school system and the democratic way of life. Relationship of education to social organization, social change and social control. Role of education in society. Prerequisite: SOCI 205 or EDCI 215.

620. Human Ecology. (3-0). Credit 3. Interrelationships between humans and their social and natural environments; human aggregations and their forms of settlement and organization. Prerequisites: SOCI 205, 206, or 613; six additional hours of social science.

621. Social Psychology. (3-0). Credit 3. Personality, social and cultural systems; development and interrelationships. Cognitive activities, motivational determinants and selectivity. Goals, structures, coordination and related factors influencing complex social groupings. Prerequisites: SOCI 205; 12 additional hours of social science.

622. Social Demography. (3-0). Credit 3. Survey of methods, theories and problems of contemporary demographic phenomena. Prerequisite: Approval of department head.

623. Measurement of Sociological Parameters. (3-0). Credit 3. Sociological research including scaling, scale analysis and experimental design. Prerequisites: Graduate classification; three hours of statistics.

624. Qualitative Methodology. (3-0). Credit 3. Course provides exposure to and critical assessment of qualitative approaches to data gathering in social science; topics include naturalistic observation, field research skills, unobtrusive measures and grounded theory construction.

625. Attitude Theory and Measurement. (3-0). Credit 3. Attitudinal and behavioral theory. Attitude measurement, scale development and evaluation. Prerequisite: Twelve hours advanced sociology and/or psychology.

626. Sociology of Power. (3-0). Credit 3. Power structures; models and theories of power; techniques for identifying power wielders; sociological presentation of interest groups, elites and pluralism. Prerequisite: SOCI 404 or 612 or equivalent.

628. Deviant Behavior. (3-0). Credit 3. Contemporary sociological approaches to deviance. Theoretical and empirical studies of major types of deviant behavior.

631. Seminar in Sociological Research. (3-0). Credit 3. Critical analysis of research procedures used by sociologists. Prerequisite: SOCI 623.

633. Demographic Methods. (3-0). Credit 3. Procedures and techniques for the collection, evaluation and analysis of demographic data; measures of population growth, composition, fertility, mortality and migration. Prerequisite: SOCI 622.

635. Sociology of Complex Organizations. (3-0). Credit 3. Comparative structures; contingency models; micro- and macro-theoretical perspectives.

681. Professional Seminar in Sociology. (1-0). Credit 1. Provides socialization to the profession of sociology; focuses on the role of the graduate student in sociology departments and other areas of professionalization; systematically introduces students to faculty members and their work; and provides instruction on how to write and publish research.

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problem in field of sociology. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Seminar approach to various specialized fields of sociology.

691. Research. Credit 1 or more each semester. Initiation and completion of research project of approved scope for an advanced degree. Prerequisite: Approval of instructor.

DEPARTMENT OF SOIL AND CROP SCIENCES

J. R. Abernathy, D. W. Altman, W. B. Anderson, E. C. Bashaw, J. B. Beard, A. J. Bockholt, N. E. Borlaug, G. R. Bowers, Jr., R. D. Brigham, K. W. Brown, J. M. Chandler, L. E. Clark, B. E. Conrad, J. T. Cothren, H. T. Cralle, M. L. Dahmer, J. B. Dixon, J. R. Dunlap, E. F. Eastin, K. M. El-Zik, M. C. Engelke, G. W. Evers, F. Fong, P. A. Fryxell, C. J. Gerard, T. J. Gerik, E. C. Gilmore, Jr., V. A. Haby, C. T. Hallmark, B. L. Harris, G. E. Hart, J. L. Heilman, F. M. Hons, G. L. Horst, L. R. Hossner, M. A. Hussey, W. R. Jordan, A. R. S. Juo, R. J. Kohel, R. J. Lascano, R. H. Loeppert, Jr., E. W. Lusas, J. E. Matocha, G. G. McBee, G. N. McCauley, K. J. McCree, M. E. McDaniel, K. J. McInnes, M. G. Merkle, M. H. Milford*, F. R. Miller, S. Miyamoto, J. Moore, P. W. Morgan, L. R. Nelson, W. R. Ocumpaugh, A. B. Onken, R. D. Palmer, A. E. Percival, G. C. Peterson, F. C. Petr, K. B. Porter, H. J. Price, J. D. Price, J. E. Quisenberry, J. C. Read, K. C. Rhee, L. W. Rooney, D. T. Rosenow, F. M. Rouquette, Jr., E. C. A. Runge (Head), K. F. Schertz, A. M. Schubert, J. W. Sij, Jr., C. E. Simpson, C. W. Smith, D. T. Smith, G. R. Smith, J. D. Smith, O. D. Smith, R. H. Smith, J. W. Stansel, D. M. Stelly, N. A. Tuleen, F. T. Turner, C. H. M. van Bavel, D. M. Vietor, R. D. Waniska, D. Weaver, R. W. Weaver, B. D. Webb, C. W. Wendt, R. P. Wiedenfeld, A. F. Wiese, L. P. Wilding, D. A. Zuberer

*Graduate Advisor

The graduate programs of the Department of Soil and Crop Sciences are designed to prepare individuals for careers in research, teaching, extension, industry and management of agronomic enterprises. Agronomy, food science and technology, genetics, plant breeding, plant physiology and soil science are the principal majors available to students.

Programs of professional study in agricultural chemistry, agricultural development, agonomy and food science and technology prepare students for professional careers and lead to the master of agriculture degree.

Research oriented programs in agronomy, food science and technology, genetics, plant breeding, plant physiology and soil science lead to a M.S. or Ph.D. degree in these fields. There is no language requirement at the M.S. or Ph.D. level. Members of the faculty have expertise in cereal chemistry, crop breeding, crop physiology, environmental agronomy, cytogenetics, plant physiology, protein chemistry, soil chemistry, soil fertility, soil genesis and classification, soil microbiology, soil mineralogy, soil physics, soil-plant-water relations, turfgrass science and weed science. Recipients of the M.S. and Ph.D. degrees may obtain a research, teaching or extension oriented position upon graduation.

Multidisciplinary programs can be arranged with other academic departments in the University. The facilities of the Electron Microscopy and Real Estate Research Centers are accessible, as are those of the Texas Water Resources Institute and the Department of Statistics.

(AGRO)

601. Grain and Cereal Crops. (3-0). Credit 3. Grain and cereal ecology, use, physiology and morphology; critical review of world literature reporting recent investigations in this field. Prerequisite: AGRO 306 or equivalent.

602. Forage Crops. (3-0). Credit 3. Pasture production, management and use. Factors affecting forage quality and animal performance; world literature.

603. Cytological and Histological Principles in Plant Breeding. (2-3). Credit 3. Modern concepts and recent developments for advanced students in plant and soil sciences and related fields employing microscopic evaluation. Specimen preparation, stain technology, theory and use of microscopes, micromanipulators, microtomes, the microtome cryostat, use of equipment in modern cytological research. Prerequisites: Graduate classification.

604. Symbiotic Nitrogen Fixation. (2-3). Credit 3. Research methodology in biological nitrogen fixation; theory of inoculum production, survival of rhizobia, nodulation process, methods of measuring and requirements for nitrogen fixation. Students conduct own experiments to learn methodology. Prerequisites: BIOL 351 or AGRO 405, PPHY 313 or equivalent.

605. Pedology. (3-0). Credit 3. Soil genesis, morphology and classification. Development of a working knowledge of soil taxonomy and diagnostic horizons used in placement of soils. Prerequisites: AGRO 301, 411 or equivalent; or approval of instructor. Two 2-day field trips for which departmental fees may be assessed to cover costs.

606. Soil Microfabric and Reconstruction Analysis. (2-6). Credit 4. Mineralogical methods suitable for soil genesis, micromorphology and reconstruction analysis; application of thin section analysis and x-ray spectroscopy to soil reconstruction. Soil variability, sample collection, fractionation and pretreatment of samples for soil matrices. Offered in alternate years. Prerequisites: AGRO 301, 310 and 411.

607. Crop Physiology. (3-0). Credit 3. Growth and productivity of major agronomic crops as related to plant physiological processes and environmental parameters, including manipulation of crop growth for enhanced production. Prerequisites: AGRO 303 and PPHY 313.

608. International Agronomic Development. (2-0). Credit 2. Overview of world food situation; role of assistance programs and international and national research centers in the development of viable agronomic research and outreach programs for the Third World; roles and importance in training programs for institutional development and service.

610. Host Plant Resistance. (3-0). Credit 3. Host plant resistance programs from the standpoint of the plant breeder, plant pathologist and entomologist. Team taught with each discipline represented. Roundtable discussion of assigned readings and lectures. Prerequisite: Approval of instructors. Cross-listed with ENTO 610 and PLPA 610.

612. Forage Crops Management. (3-0). Credit 3. Forage plant development, population dynamics and growth behavior patterns. Applications of ecological and physiological principles to forage management. Principles and practices of forage crops investigations; current literature and concepts. Prerequisites: AGRO 308 or approval of instructor.

615. Reclamation of Drastically Disturbed Lands. (3-0). Credit 3. Theoretical and practical aspects of reclamation of lands disturbed during mining of lignite, uranium, phosphorous, oil shale and other minerals and disturbances due to industrial activities. Emphasis on physical and chemical characteristics of disturbed materials and their impact on establishment of permanent vegetation. Prerequisite: AGRO 301 or approval of instructor.

617. Advanced Soil Physics. (3-3). Credit 4. Physical properties of soil; dynamics of soil, water and ion movement, soil aeration and soil thermal relationships. Prerequisites: AGRO 445 or equivalent, a two-semester course in physics, and one semester of calculus. (Offered in 1988-89 and alternate years thereafter.)

618. Advanced Soil Analysis. (2-3). Credit 3. Fundamental procedures for analysis of soils and sediments including chemical, spectrophotometric, electrometric, chromatographic and sample handling; methods important to the soils researcher and analyst. Prerequisite: AGRO 422 or approval or instructor.

620. Saline and Sodic Soils. (2-3). Credit 3. Fundamentals in diagnosis, nature and management of saline and sodic soils especially as they relate to physiochemical properties of soils and agronomic phases of irrigation agriculture. Water quality as related to growth and development of crop plants. Prerequisite: AGRO 445 or approval of instructor.

621. Principles of Crop Physics. (3-3). Credit 4. Basic principles of environmental physics and their application to current research in crop physiology and crop ecology. Control and measurement of environmental conditions in growth chambers (radiation, temperature, humidity, carbon dioxide). Prerequisite: Approval of instructor.

622. Environmental Aspects of Crop-Water Relations. (3-0). Credit 3. Review and synthesis of physical processes that affect crop-water balance and water use by plant communities with special reference to productivity, water use efficiency and water management in crop production. Prerequisites: AGRO 412 and 445; two semesters of plant physiology.

624. Physical Chemistry of Soils. (3-3). Credit 4. Physical chemistry of clay minerals and inorganic and organic soil colloids; specific and non-specific absorption; kinetic processes and chemical equilibria in soils. Prerequisites: AGRO 626; CHEM 324 or approval of instructor.

626. Soil Mineralogy. (3-3). Credit 4. Crystal structures and properties of more important minerals in soils and sediments especially clay minerals combined with identification techniques involving X-ray diffraction, electron microscopy, infrared and chemical methods.

627. Soil Fertility Relationships. (3-0). Credit 3. Behavior of nitrogen, phosphorous and potassium in soils. Secondary nutrients, micronutrients and soil acidity and liming. Interpretation of fertility data from current laboratory, greenhouse and field experiments. Prerequisites: AGRO 422; PPHY 313.

630. Cereal Grains for Human Food. (3-3). Credit 4. Fundamental concepts of dry milling, wet milling, oil extraction, baking, malting, brewing, storage, sanitation, and quality evaluation and control interrelated with physical and biochemical properties of cereals and their products. Use of instruments and techniques to evaluate cereal quality. Prerequisite: Approval of instructor. Cross-listed with FSTC 630.

641. Plant Breeding I. (3-0). Credit 3. Theoretical and practical aspects of plant breeding including genetic basis. Application of breeding methods and interdisciplinary considerations in breeding problems. Prerequisites: AGRO 304 or HORT 404; GENE 301; STAT 652.

642. Plant Breeding II. (3-0). Credit 3. Expectations of genetic improvement for different plant breeding methods; relative efficiency for crops of different reproductive mechanisms. Genetic variances, covariances and genotype-environment interaction components of variance used in planning selection procedures. Prerequisites: AGRO 641; GENE 613; STAT 619.

650. Chemical Weed Control. (2-3). Credit 3. Families of herbicides. Relationship of molecular structure to herbicidal activity, mode of action, pathways of degradation and herbicidal interactions. Prerequisite: AGRO 450 or approval of instructor.

651. Weed Biology and Ecology. (2-2). Credit 3. Fundamentals of weed invasion, development, persistence and competition with agronomic crops. Consideration of ecological concepts important to weed-crop relationships as influenced by weed control and other cultural practices. Practical consideration of integrated weed management systems and weed identification. Prerequisites: PPHY 313 and AGRO 303.

681. Seminar. (1-0). Credit 1 each semester. For graduate students and staff members in soils and crops. Presentation and discussion of special topics and research data in field of agronomy. Participation required of all graduate students in agronomy.

684. Professional Internship. Credit 1 to 4. Program planned to provide professional training in student's particular field of interest. Faculty and employer will supervise the activity. Work-study will be planned as a part of the master of agriculture degree program in agricultural chemistry, crops and soils. Prerequisite: Approval of instructor.

685. Problems. Credit 1 to 4 each semester. Advanced problems in some phase of agronomy not directly related to thesis or dissertation.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of agronomy. May be repeated for credit. Prerequisite: Approval of department head.

691. Research. Credit 1 or more each semester. Investigations leading to thesis or dissertation.

SPECIAL EDUCATION

(See Educational Psychology)

DEPARTMENT OF SPEECH COMMUNICATION AND THEATRE ARTS

A. Gonzalez, M. L. Greenwald, R. L. Ivie, M. J. Medhurst, W. F. Owen, T. R. Peterson, R. D. Pomo, J. H. Powers, K. Ritter (Head), R. H. Schultz, R. L. Street, Jr., M. J. Sunnafrank, M. R. Vickery

SPEECH COMMUNICATION (SCOM)

685. Problems. Credit 1 to 3 each semester. Directed studies in specific problem areas in speech communication. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4 each semester Selected topics in an identified area of speech communication. May be repeated for credit. Prerequisite: Approval of instructor.

THEATRE ARTS (THAR)

685. Problems. Credit 1 to 3 each semester. Directed studies in specific problem areas in theatre. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4 each semester Selected topics in an identified area of theatre. May be repeated for credit. Prerequisite: Approval of instructor.

DEPARTMENT OF STATISTICS

J. Beran, R. J. Carroll (Head), C. K. Chui, D. B. H. Cline, P. F. Dahm, J. Eltinge, R. L. Eubank, R. J. Freund, C. E. Gates, E. Giné, J. D. Hart, A. I. Hillis, R. R. Hocking, T. Hsing, O. C. Jenkins, M. T. Longnecker, J. H. Matis, H. J. Newton, E. Parzen, L. J. Ringer*, W. B. Smith, C. H. Spiegelman, W. Thomas, T. E. Wehrly, J. Zinn

*Graduate Advisor

The Department of Statistics offers a graduate program leading to the degrees of master of science or doctor of philosophy. The department jointly sponsors graduate work in econometrics and cooperates closely with all subject matter area departments in setting up flexible minor programs in statistics.

The Department of Statistics offers two options in its master's degree programs: (1) the M.S. (thesis option) which requires the preparation of a thesis and, (2) the M.S. (non-thesis option) which requires more formal course work in lieu of the thesis. Both programs provide a balanced training in statistical methods and statistical theory and are intended to prepare the student to adapt statistical methodologies to practical problems.

The aim of the Ph.D. program is to provide comprehensive and balanced training in statistical methods and statistical theory. Particular emphasis will be placed on training students to independently recognize the relevance of statistical methods to the solution of specific problems and to enable them to develop new methods when they are needed. The training will also aim at conveying a sound knowledge of existing statistical theory, including the mathematical facility to develop new results in statistical methodology. At the same time, the program will be kept sufficiently flexible to permit students to develop their specific interests.

The following courses are offered on an irregular basis: STAT 603, 615, 617, 618, 621, 625, 628, 629, 632, 634, 635, 640, 671, 672, 673, 674. Contact the graduate advisor for specific offerings for any given term.

(STAT)

601. Statistical Analysis. (3-2). Credit 4. For students in engineering, physical and mathematical sciences. Introduction to probability, probability distributions and statistical inference. Hypotheses testing using t and F tests. Introduction to methods of analysis such as tests of independence, simple regression, analysis of variance with some consideration of planned experimentation. Prerequisite: MATH 122 or 152.

602. Statistical Methods of Regression Analysis. (3-0). Credit 3. Linear, nonlinear, nonparametric and logistic regressions; methodologies and their statistical foundations for detection of collinearity, outliers and correlation in errors or independent variables. Prerequisite: STAT 601, 610, MATH 423 or equivalent.

603. Biological Statistics including Bio-Assay. (3-0). Credit 3. Bio-assay for quantitative and quantal responses. Absolute and comparative potencies, dose-, time- and dose x time response curves. Application of probit analysis to insecticide and radiation dose response studies. Prerequisite: STAT 601 or 652.

604. Special Problems in Statistical Computations and Analysis. (3-0). Credit 3. Computer algorithms for programming; statistical analysis, efficient uses of existing statistical computer programs, generation of random numbers and statistical variables, programming of simulation studies, selected topics in statistical analysis not covered in STAT 601 or 652. Prerequisites: CPSC 201; STAT 602 or 608 or 619.

606. Design of Experiments. (3-0). Credit 3. Fundamental concepts in the design of experiments, justification of linear models, randomization, principles of blocking and the use of concomitant observations; construction and analysis of basic designs including confounding, fractional replication, composite designs and incomplete block designs. Prerequisite: STAT 619 or approval of department head.

607. Sampling. (3-0). Credit 3. Planning, execution and analysis of sampling from finite populations; simple, stratified, multistage and systematic sampling; ratio estimates. Prerequisite: STAT 601 or 651.

608. Least Squares and Regression Analysis. (3-0). Credit 3. Regression analysis, simple, multiple and curvilinear; orthogonal polynomials. Analysis of non-orthogonal and incomplete experiments by least squares methods, computer methods for least squares problems. Prerequisite: STAT 601 or 652.

609. Order Statistics and Non-Parametric Methods. (3-0). Credit 3. Application of distribution-free and rank procedures for estimation, confidence interval construction and hypothesis testing. Both exact and approximate methods considered. Prerequisite: STAT 601 or 652.

610. Theory of Statistics I. (3-0). Credit 3. Brief introduction to probability theory. Distributions and expectations of random variables, transformations of random variables and order statistics. Generating functions and basic limit concepts. Prerequisite: MATH 221 or 253 or equivalent.

611. Theory of Statistics II. (3-0). Credit 3. Theory of estimation and hypothesis testing. Point estimation, interval estimation, sufficient statistics, decision theory, most powerful tests, likelihood ratio tests, chi-square tests. Prerequisite: STAT 610 or equivalent.

612. Theory of Linear Models. (3-0). Credit 3. Theory of least squares, theory of general linear hypotheses and associated small sample distribution theory, analysis of multiple classifications. Prerequisites: MATH 423; STAT 611 or equivalent.

613. Intermediate Theory of Statistics. (3-0). Credit 3. General theory of estimation and sufficiency including maximum likelihood and minimum variance estimation. Neyman-Pearson theory of testing hypotheses. Elements of decision theory. Prerequisites: MATH 409; STAT 611.

614. Advanced Theory of Statistics. (3-0). Credit 3. Approximation theorems of mathematical statistics. Convergence and limiting distributions. Sample statistics and transformations. U, V, Von-Mises, M, L and R statistics. Robustness and asymptotic relative efficiency. Prerequisite: STAT 611 or approval of instructor.

615. Stochastic Processes and Time Series. (3-0). Credit 3. Survey of the theory of Poisson processes, discrete and continuous time Markov chains, renewal processes, birth and death processes, diffusion processes and covariance stationary processes. Prerequisites: MATH 409, 601; STAT 611.

616. Multivariate Analysis. (3-0). Credit 3. Multivariate normal distributions and multivariate generalizations of classical test criteria, Hotelling's T^2, discriminant analysis and elements of factor and canonical analysis. Prerequisites: MATH 409; STAT 601 or 652, 611, 612.

617. Theory of Sampling. (3-0). Credit 3. General randomization theory of multistage sampling of finite populations, sampling with and without replacement and with equal and unequal probabilities, ratio and regression estimates, analytic studies and multiframe problems. Prerequisites: STAT 607; approval of instructor.

618. Advanced Experimental Design. (3-0). Credit 3. Randomization theory of experimental design. General analysis of experimental design models. Role of Galois fields and their related finite geometries in the general p^n factorial representation, confounding and fractional replication. Construction and analysis of balanced and partially balanced incomplete block designs. Designs for special situations. Prerequisites: STAT 606, 611, 612.

619. Analysis of Variance. (3-0). Credit 3. Extensive treatment of the analysis of variance for the analysis of designed experiments: randomized blocks, Latin squares, split plot and factorials. Evaluation of treatment response: multiple comparisons, orthogonal contrasts and regression. Analysis using concomitant information. Some consideration of the analysis of non-orthogonal data. Prerequisite: STAT 601 or 652.

621. Advanced Topics in Statistical Theory. (3-0). Credit 3. Topics in statistical theory not provided for in other courses and readings of current research topics in statistical theory published in leading statistical journals. Prerequisite: Approval of instructor.

625. Statistical Methods in Reliability. (3-0). Credit 3. Statistical theories pertinent to solution of engineering problems in reliability introduced, established and applied. Distribution and failure theory including exponential, log normal, gamma and Weibull. Parameters studied include mean time to failure, failure rate, variances and standard deviations, confidence limits and tests of hypotheses. Prerequisites: INEN 614; STAT 601; or approval of instructor.

626. Statistical Methods of Process Control and Optimization. (3-0). Credit 3. Introduction to statistical time series analysis. Autocorrelation and spectral characteristics of univariate, autoregressive, moving average models. Identification, estimation and forecasting. Introduction to process control using interrelationships among multiple time series. Prerequisite: STAT 601 or approval of instructor.

628. Mathematical Programming I. (3-0). Credit 3. Developing and understanding computer algorithms for solving unconstrained optimization and linear programming problems. Parametric and sensitivity analysis. Network flow analysis. Special algorithms. Prerequisites: MATH 304 or equivalent or approval of instructor.

632. Statistical Decision Theory. (3-0). Credit 3. Decision rules, quantifying risks and choosing an action, Bayes or minimax solutions, sequences of decisions over time, sequential analysis. Prerequisite: STAT 611 or approval of instructor.

634. Response Surface Design and Analysis. (3-0). Credit 3. Definition of response surface and relation to multiple regression; ridge analysis; first, second and third order designs for response surface estimation; optimization of response surface designs for various criteria; the Box-Draper theory and EVOP. Prerequisites: STAT 606, 602 or 608.

635. Application of Stochastic Processes to the Natural Sciences. (3-0). Credit 3. Basic concepts, Random walks, Markov chains, branching processes, Markov processes in continuous time, homogeneous and nonhomogeneous processes, multi-dimensional processes, queuing processes, epidemic processes, competition and predation, diffusion and non-Markovian processes. Prerequisites: STAT 611 or 615; approval of instructor.

636. Methods in Multivariate Analysis. (3-0). Credit 3. Multivariate extensions of the chi-square and t-tests, discrimination and classification procedures. Applications to diagnostic problems in biological, medical, anthropological and social research. Multivariate analysis of variance, principal component and factor analysis, canonical correlations. Prerequisites: MATH 423, STAT 602 or 608.

637. Statistical Methods in Ecology. (3-0). Credit 3. Derivation and application of statistical distributions for sampling models, birth-death processes, time intervals, size models, heterogeneous and clustered models in ecology. Stochastic models for population growth, competition and predation and multi-dimensional processes. Prerequisites: STAT 601 or 652 with approval of instructor.

640. Use of Statistical Software for Computers. (1-0). Credit 1. Brief survey of statistical software. Instruction on use of software currently used at this University. Prerequisite: STAT 602 or 608 or 619.

651. Statistics in Research I. (3-0). Credit 3. For graduate students in other disciplines. A non-calculus exposition of the concepts, methods and usage of statistical data analysis. T-tests, analysis of variance and linear regression. Prerequisite: MATH 102 or equivalent.

652. Statistics in Research II. (3-0). Credit 3. Continuation of STAT 651. Concepts of experimental design, individual treatment comparisons, randomized blocks and factorial analysis, multiple regression, x^2 tests and a brief introduction to covariance, non-parametric methods and sample surveys. Prerequisite: STAT 651.

671. Methods of Statistical Data Modeling I. (3-0). Credit 3. Introduction to new methods of statistical analysis, especially statistical data modeling, exploratory data analysis, adaptive and robust estimation. Prerequisite: STAT 611 or equivalent.

672. Methods of Statistical Data Modeling II. (3-0). Credit 3. Continuation of STAT 671. Exploratory data analysis, multiparameters, nonparametric regression, censored sample analysis and confirmatory statistical inference. Prerequisites: STAT 611, 671.

673. Time Series Analysis I. (3-0). Credit 3. Introduction to diverse modes of analysis now available to solve for univariate time series; basic problems of parameter estimation, spectral analysis, forecasting and model identification. Prerequisite: STAT 611 or equivalent.

674. Time Series Analysis II. (3-0). Credit 3. Continuation of STAT 673. Multiple time series, ARMA models, tests of hypotheses, estimation of spectral density matrix, transfer function and forecasting. Prerequisites: STAT 611 or equivalent; 673.

684. Professional Internship. Credit 1 to 3. Practicum in statistical consulting for students in Ph.D. program. Students will be assigned consulting problems brought to the Department of Statistics by researchers in other disciplines. Prerequisite: Master's in statistics or equivalent.

685. Problems. Credit 1 to 6. Individual instruction in selected fields in statistics; investigation of special topics not within scope of thesis research and not covered by other formal courses. Prerequisites: Graduate classification; approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of statistics. Open to non-majors. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation. Prerequisite: Graduate classification.

See Econometrics for descriptions of related courses.

SYSTEMS ENGINEERING

(See Interdisciplinary Engineering)

TEACHER EDUCATION

(See Interdisciplinary Education)

TEXAS A&M UNIVERSITY — BAYLOR COLLEGE OF MEDICINE UNIVERSITY OF TEXAS SYSTEM

(TAMU)

699. Courses at Baylor College of Medicine or at Institutions Within The University of Texas System. Credit 1 or more each semester or summer session. Designed to serve registration needs of graduate students who will engage in graduate work through interinstitutional cooperative agreements with Baylor College of Medicine and with The University of Texas System. Specific arrangements for registration in this course must be made through the Office of Graduate Studies at Texas A&M University well in advance of the time that the student expects to enroll in the course. Prerequisites: Written permission of the chair of the student's Advisory Committee, the head of the student's major department, the director of graduate studies at Texas A&M University and the dean of the Graduate School of Baylor College of Medicine or the proper authority of the institution within The University of Texas System at which the student proposes to take the course.

THEATRE ARTS

(See Speech Communication and Theatre Arts)

DEPARTMENT OF URBAN AND REGIONAL PLANNING

S. I. Bame, P. R. Berke, R. G. Echols, J. H. Hinojosa* (Head), R. B. Hull IV, M. M. McCarthy, D. L. Pugh*, J. E. Rodiek, W. G. Roeseler*, K. N. A. Safwat, A. D. Seidel, V. G. Stover, D. A. Sweeney, R. S. Ulrich, D. E. Wenger

*Graduate Advisor

The graduate program in the Department of Urban and Regional Planning serves the following distinct purposes: to provide the planning profession with competent personnel in government and private industry through the master of urban planning degree program; to prepare men and women for entrepreneurships in land development through the master of science degree with a major in land development; and to develop high level researchers and policy analysts through the doctor of philosophy degree program in urban and regional science.

Candidates for these degrees are encouraged to apply from a broad range of disciplines, as these programs are interdisciplinary in character. A close, effective relationship exists between faculty and students in the department. Major supporting fields include accounting, architecture, education, engineering, finance, humanities, landscape architecture, physical and social sciences and veterinary public health.

(PLAN)

601. Introduction to Urban Planning. (3-9). Credit 6. Basic issues of urban development with respect to physical, social, economic and general environmental aspects. A comprehensive city plan will be prepared for a community of approximately 50,000 or less in Texas.

602. Metropolitan Development Planning. (3-9). Credit 6. Preparation of a major plan element of the comprehensive plan for a large metropolitan area. Students work in cooperation with metropolitan or municipal planning staffs, conduct general research; analysis and synthesis; develop particularized plans; and draft implementing tools. Each participant assigned specific responsibilities.

603. Regional and Area Planning. (3-9). Credit 6. General course in regional planning, resources conservation and exploration addressing a predominantly agricultural or mining area of Texas or the general Southwest. Students prepare specific plan documents in cooperation with a regional or state planning agency.

604. Regional Planning and Metropolitan Impacts. (3-9). Credit 6. Plans and impact statements prepared for specific categories of the development plan for a region containing one or more major metropolitan areas. Inter-regional relationships analyzed with respect to urban management, environment, transportation, health care, conservation and other aspects.

612. Transportation in City Planning. (2-3). Credit 3. Influence of transportation in shaping urban form; relationships between land use and transportation; conceptual layout of street systems. Trends in urban development; site development circulation and relationships to the street system. Guidelines for the redevelopment of existing streets and the adjacent land. Cross-listed with CVEN 612.

613. Planning Methods and Techniques. (3-0). Credit 3. Methods and techniques of research, data collection and analysis; coordination of planning process with public policy and plan implementation.

615. Contemporary Urban Affairs. (3-0). Credit 3. Contemporary problems of urban and metropolitan areas: housing, employment, education, health, government and others.

623. Development Planning in Third World Countries. (3-0). Credit 3. Lectures and research projects of "Third World" development problems; application of planning methods and techniques towards long-term solutions in the context of unfolding contemporary world events. Role of international lending institutions, technical assistance and funding requirements.

630. Survey of Health Planning Processes. (3-0). Credit 3. Application of planning process to health systems development. Historical and legal basis, principal agencies and institutions, role of health planner, citizen participation.

631. Planning and Programming Health Systems. (3-0). Credit 3. Specific health planning issues; distribution of manpower and facilities, financial resources, local-federal partnership, system's organization and governance.

632. Applied Regional Health Planning. (3-9). Credit 6. Practical applications of health planning theory and techniques. Students work in cooperation with state or regional health planning agencies to analyze and develop specific plans and solutions for current health planning problems. Prerequisite: Approval of instructor.

636. Housing and the Elderly. (3-0). Credit 3. Examination of the special housing needs for the elderly and the implications of such needs to the planning of residential environments.

640. Law and Legislation Related to Planning. (3-0). Credit 3. Legislative process and planning legislation. Enabling legislation and legal tools of planner: zoning, subdivision ordinances, eminent domain, extraterritorial jurisdiction and other related planning instruments.

641. Problems of Environmental Planning Administration. (3-0). Credit 3. State and federal legislation pertaining to environmental and consumer protection aspects of urban planning; review of administrative procedures; major judicial decisions.

642. Land Development Law. (3-0). Credit 3. Survey of real estate law with emphasis on Texas law. Review of constitutional issues and basic legal concepts, including estates in land, contracts; private and public sector land use controls.

654. Planning Administration and Management. (1-0). Credit 1. Issues of professional practice in public and private sectors.

656. Housing and Community Facilities. (3-0). Credit 3. Housing, its development, planning, marketing, designing, financing and production. Student problems dealing with urban renewal, neighborhood structure and community facilities.

657. Systems Analysis in Urban and Regional Planning. (3-0). Credit 3. Concepts and methods of systems analysis and their application to the planning process such as problem description and goal formulation, modeling and simulation, optimization of alternatives, usage of computers. Role and place of urban systems theory. Illustrative case studies.

658. Plan Implementation. (3-0). Credit 3. Techniques of implementing major urban development programs and plans; capital improvements programming and budgeting; overview of regulatory measures; public involvement process; fiscal planning; federal financial assistance and application procedures.

661. Information and Communication in Planning. (2-2). Credit 3. Types and sources of planning related information; use of verbal, printed and electronic media in communicating planning information and formulating alternative solutions to community development problems.

664. Theory of City Planning. (3-0). Credit 3. Post World War II theories of city planning will be reviewed and debated. The underlying socio-economic, political systems expressed in physical form will be analyzed and critiqued. Alternative conceptual models of the planning process will be examined.

665. Comprehensive Planning. (3-0). Credit 3. Comprehensive urban and regional planning process; relationship to plan documents and to management decisions; budgeting and financing. Criteria for location of key activity centers; three-dimensional conceptualization of planning goals and formulation of implementation programs; institutional roles and public involvement.

666. Evolution of Contemporary Planning. (3-0). Credit 3. Survey of American planning beginning with colonial town plans; the French and English concepts; Pierre l'Enfant's Washington; Olmsted, Kessler and the City Beautiful movement; company towns; garden cities of the 1930's; planning with the physical environment; parkways and freeways; Segoe, McHarg; planning stereotypes; present-day concepts and accomplishments.

667. Development Feasibility and Design. (3-9). Credit 6. Selected residential and non-residential development projects of varying size analyzed by student teams with respect to the following: economic feasibility and cash flow; site analysis; and design concept. Prerequisite: Approval of instructor. Cross-listed with ARCH 667 and LAND 667.

668. Land Development Practice. (2-2). Credit 3. Strategies, methods and techniques of land development including: site selection criteria, urban infrastructure; market evaluation; conceptual arrangement of land uses and structures; conceptual design and regulatory considerations; lending institutions; location theory; value theories; regulatory agencies.

669. Urban Infrastructure Planning. (2-2). Credit 3. Identification of urban infrastructure requirements; criteria for utility location and design; projection of the conversion of land to urban uses; estimating demand for urban services; anticipating the effect of urbanization on storm runoff; and municipal practice in financing infrastructure extensions.

670. Urban Public Transportation Planning. (2-3). Credit 3. Planning, operations, fiscal, management and legal aspects of urban, rural and regional public transportation modes. Preparation of transportation systems program elements. Cross-listed with CVEN 670.

672. Urban Transportation Study. (3-3). Credit 4. Procedures and techniques of traditional urban transportation studies. Study design, data collection and processing, trip generation, trip distribution, traffic assignment and mode choice. Data reliability; sketch planning and abbreviated study techniques. Cross-listed with CVEN 672.

673. Comprehensive Transportation Planning and Urban Development. (3-9). Credit 6. Comprehensive plan for multiple urban transport modes are prepared for selected metropolitan area. Following data collection and problem identification plans and programs for 10-15-25 year goals are prepared. Interrelationship of transportation and land development are stressed, as well as opportunities for public-private partnership. Cross-listed with CVEN 671.

675. Theory of Planning and Urbanism. (2-0). Credit 2. Theories of planning and urbanization in world literature; physical community design as expression of ideology and cultural value systems.

678. Planning for Social Services. (3-0). Credit 3. Survey of physical and institutional requirements for delivery of social services: welfare, senior citizens, child care and youth programs; juvenile delinquency and criminal correction programs; public recreation programs; relocation of persons displaced by public action; health care delivery; housing policies; animal and pest control. Analysis and planning techniques.

684. Professional Internship. Credit 1 to 8. Professional practice under approved arrangement with public or private agencies.

685. Problems. Credit 1 to 6 each semester. Individual and group problems dealing with application of planning theory and practice. Opportunities to select foreign and domestic planning project of special interest.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified field of urban and regional planning. May be repeated for credit.

690. Theory of Research in Urban and Regional Science. (3-0). Credit 3. Survey of research methodology; consideration of research strategy and design; preparation of proposals and reports; review/evaluation of current research in relevant subfields of urban and regional science.

691. Research. Credit 1 or more each semester. Ph.D. research and dissertation.

DEPARTMENT OF VETERINARY ANATOMY

G. R. Bratton (Head), R. C. Burghardt, D. L. Busbee, W. L. Dees, W. Flory, W. E. Haensly, M. A. Herron, T. R. Irvin, L. Johnson, W. R. Klemm, J. E. Martin, N. H. McArthur, M. J. Shively, R. F. Sis, L. C. Skow, G. G. Stott, E. Tiffany-Castiglioni*

*Graduate Advisor

The department has as its primary goal for its graduate programs the advancement of biomedical science through original research. In addition, the department has the obligation to equip students for teaching of veterinary or comparative anatomy, developmental anatomy, histology, neuroscience, cell biology or genetics.

The department offers advanced study towards degrees in veterinary anatomy and administers interdisciplinary programs leading to a Ph.D. in veterinary medical sciences, genetics, toxicology, and food science. Programs are individualized for each student by a graduate committee and its chairperson.

The training in macroscopic anatomy includes a variety of domestic species and can include wild, aquatic and laboratory animals. The training in microscopic anatomy includes histology, histochemistry, cytology and ultrastructure (electron microscopy). Students have an opportunity to develop skills in teaching and research methods involving gross anatomy, light microscopy, electron microscopy (scanning and transmission), histochemistry, cell culture, cell biology, genetics and assorted biochemical and physiological methodologies. Special interdisciplinary training is provided in the following areas: 1) veterinary medical sciences, 2) aquatic animal medicine, 3) environmental toxicology, 4) genetic toxicology, 5) reproductive toxicology, 6) neuroscience and 7) cell and molecular biology.

The general procedural rules are those specified in the *Graduate Catalog.* A degree program of planned course work is developed by the student and the committee. All doctoral students majoring in veterinary anatomy are expected to demonstrate proficiency in or to complete VTAN 601 (gross anatomy) and VTAN 602 (histology). Additional course work or proficiency is recommended in the following areas: cytology/ultrastructure, genetics, biochemistry, pathology, physiology, statistics/computer usage.

(VTAN)

601. Anatomy. (2-6). Credit 4 each semester. Topographical dissection of one of the following domestic animals: horse, ox, dog or cat. May be taken more than once but not to exceed 12 hours of credit toward a graduate degree. Prerequisite: VTAN 912 or 305 or equivalent.

602. Histology. (2-6). Credit 4. Structure of mammalian cells and tissues at the light and electron microscopic levels with emphasis on functional correlations. Prerequisite: Approval of instructor.

603. Neuroanatomy. (2-6). Credit 4. Gross, developmental and microscopic anatomy of nervous system of selected laboratory and domestic animals. Prerequisite: Approval of instructor.

604. Neuroendocrine Anatomy. (2-6). Credit 4. Comparative morphology of the neuroendocrine system of selected laboratory and domestic animals: the light and electron microscopy of the hypothalamus, pituitary, thyroid, parathyroid, adrenal, testes, ovary and pineal glands. Prerequisite: Approval of instructor.

606. Neuroanatomical Systems in Laboratory Animals. (3-0). Credit 3. Gross and microscopic anatomy of laboratory animal neural systems (somatosensory, brainstem reticular, autonomic, learning/memory, limbic, locomotor), brain atlases, stereotaxic surgery, histology. Prerequisite: VTAN 910 or 305 or equivalent.

609. Anatomy of Reproductive Systems. (2-6). Credit 4. Gross and microscopic anatomy of the reproductive systems of domestic animals. Prerequisite: VTAN 910 or 601 or 602 or equivalent. (Offered in 1990 and in alternate years thereafter.)

612. Mammalian Embryology. (3-3). Credit 4. Embryology of domestic mammals; gametogenesis, fertilization, cell proliferation and differentiation, and organogenesis; selected commonly occurring congenital defects of domestic animals used to emphasize embryologic sequences and processes. Prerequisite: VTAN 601 and 602 or approval of instructor. (Offered in 1991 and in alternate years thereafter.)

617. Cell Biology. Credit 1 to 5. Structure and function of eukaryotic cells discussed on a comparative basis to seek out basic organization of complex cells and their parts. Prerequisite: BIOL 413 or approval of instructor. Cross-listed with BIOL 617.

640. Neurobiology. (3-3). Credit 4. Neurobiological information ranging from single cell function to the physiology of behavior. Experiments include use of common electrophysiological instruments. Prerequisite: ZOOL 434 or approval of instructor.

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work in anatomy, cell and molecular biology, and cell toxicology.

685. Problems. Credit 1 to 4 each semester. Problems in either gross or microscopic anatomy, cell biology, toxicology or genetics along lines chosen by the individual. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of veterinary anatomy. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Original research on selected thesis problem in anatomy, cell biology, genetics or toxicology.

DEPARTMENT OF VETERINARY LARGE ANIMAL MEDICINE AND SURGERY

J. A. Auer, T. L. Blanchard, K. W. Bretzlaff, G. W. Brumbaugh, G. K. Carter, P. W. Dean, R. G. Elmore, S. A. Greene, J. R. Joyce, T. R. Kasari, R. J. Martens (Head), W. C. McMullan, E. L. Morris, A. J. Roussel, W. W. Ruoff, J. Schumacher, T. S. Taylor, J. P. Watkins, M. F. Young

(VLAM)

601. Control of Diseases of Cattle. (3-0). Credit 3. Etiology, epidemiology, immunology, preventive measures and management practices pertinent to disease in feedlot cattle. Prerequisites: Baccalaureate degree; approval of department head.

603. Surgery. Credit 1 to 8 each semester. Special surgery of large animals. May be taken more than once but not to exceed 8 hours of credit toward a graduate degree. Prerequisite: D.V.M. degree.

612. Diagnostic Radiology. Credit 2 or 3 each semester. Radiographic interpretation of domestic animals; film reading. Use of special techniques; contrast media and diagnostic aids. May not exceed 3 hours of credit toward a graduate degree. Prerequisite: D.V.M. degree.

621. Reproductive Diseases of Female Domestic Animals. Credit 1 to 4. Diagnosis, treatment and control of diseases primarily affecting reproduction in female domestic animals. May be taken more than once but not to exceed 4 hours of credit toward a graduate degree. Prerequisite: D.V.M. degree.

622. Andrology. Credit 1 to 4. Diagnosis, treatment and control of diseases primarily affecting reproduction in male domestic animals. Evaluation of semen and its preparation for use by artificial insemination. May be taken more than once but not to exceed 4 hours of credit toward a graduate degree. Prerequisite: D.V.M. degree.

681. Seminar. (1-0). Credit 1. Current scientific work in medical and surgical fields in and related to large animal medicine and surgery. May be repeated for credit. Prerequisites: D.V.M. degree and approval of department head.

685. Problems. Credit 1 to 8 each semester. Original investigations of problems in the field of large animal surgery, therapeutics or radiology. May be repeated for credit. Prerequisites: D.V.M. degree and approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis.

DEPARTMENT OF VETERINARY MICROBIOLOGY AND PARASITOLOGY

W. C. Berry, E. W. Collisson, T. M. Craig, B. L. Doughty, A. K. Eugster, T. A. Ficht, D. L. Graham, B. M. Hargis, F. C. Heck, M. C. Kemp, D. H. Lewis, D. S. Linthicum, C. W. Livingston, Jr., R. W. Loan, B. Panigrahy, C. M. Scanlan, R. B. Simpson, J. P. Smith, Jr., I. R. Tizard* (Head), G. G. Wagner*, J. D. Williams, G. N. Woode

*Graduate Advisor

The Department of Veterinary Microbiology and Parasitology offers programs of study leading to the M.S. and Ph.D. degrees in veterinary microbiology and the M.S. degree in veterinary parasitology. The programs are designed to prepare the graduate for a career in research, teaching, diagnostic work or some other related area in microbiology or parasitology. Faculty specialty areas include bacteriology, mycology, virology, immunology, protozoology, helminthology, entomology, molecular genetics, avian diseases and aquatic animal medicine.

The department requires no foreign language for the Ph.D. degree program.

VETERINARY MICROBIOLOGY (VTMI)

643. Pathogenic Bacteriology I. (3-4). Credit 4. Pathogenic bacteria, their cultural and biological characteristics and pathogenicity. Prerequisite: Minimum of eight hours of undergraduate microbiology.

644. Rickettsial and Chlamydial Organisms. (3-0). Credit 3. Organisms in the orders Rickettsiales and Chlamydiales which are of importance in the medical sciences.

645. Host-Agent Interactions in Veterinary Medicine. (3-0). Credit 3. Basic concepts of infection versus disease. Interdisciplinary approaches to problems in microbiology; inducible host responses, agent escape mechanisms and movement of potential pathogens in the ecosystem. Prerequisite: VTMI 405 or equivalent.

647. Virology. (3-3). Credit 4. Virus infections in animals; types of infections, mode of transmission, intracellular pathology, epidemiology, isolation and identification of inciting agents. Tissue cultivation, animal inoculations and diagnostic tests. Prerequisite: VTMI 438 or equivalent.

648. Medical Mycology. (3-3). Credit 4. Actinomycetes, yeasts and molds that are pathogenic to humans and animals; morphology, cultural characteristics, pathogenicity and identification. Practice consists of exercises in cultural methods, morphological characteristics, biochemical reactions and diagnosis. Prerequisite: Minimum of eight hours of undergraduate microbiology.

649. Immunology. (3-0). Credit 3. Humoral and cell mediated arms of the immune responses; relative relationships and immunochemical applications. Antigen-antibody reactions pertinent to diagnostic serology and *in vitro* cell-mediated methods.

650. Experimental Immunology. (3-3). Credit 4. Familiarization, development and integration of techniques into experimental design of immunologic investigation. Virus and protein purification, immunofluorescence, agar diffusion, immunoelectrophoresis, germ free animal techniques and specialized serologic tests. Prerequisites: BICH 410 or equivalent; eight hours of microbiology.

654. Tissue Culture Techniques. (1-9). Credit 4. Tissue culture techniques as they apply to a wide range of biological problems. Principles of cell, organ and explant culture *in vitro* and the technical skills required to use these techniques. Prerequisites: Graduate classification; VTMI 647 or equivalent.

655. Pathogenic Bacteriology II. (3-3). Credit 4. Practical considerations for recovery, characterization and identification of anaerobic bacteria and the relation of these organisms to health and disease. Intensive training in application of techniques for processing anaerobic bacteria. Prerequisite: Eight hours of microbiology including VTMI 643 or its equivalent.

661. Diseases of Fish. (3-4). Credit 4. Etiology, epidemiology, pathology, symptoms, diagnosis, treatment and prevention of infectious diseases of propagated and wild fish. Prerequisite: Approval of instructor.

662. Advanced Immunologic Concepts. (3-0). Credit 3. Immunologic considerations of natural occurring and inducible cancer in animals. Cell mediated and humoral immunologic responses. Detailed discussions on diverse topics which reflect new, pertinent information available in the current literature. May be repeated once for credit. Prerequisites: VTMI 438, 649 or equivalent and approval of instructor.

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work and research in field of microbiology and related subjects. Prerequisite: Graduate major or minor in microbiology or related fields.

685. Problems. Credit 1 to 4 each semester. Problems course in microbiology. Prerequisites: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of veterinary microbiology. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation.

VETERINARY PARASITOLOGY (VPAR)

601. Parasitology. (3-3). Credit 4. Important helminth parasites of domestic and laboratory animals; their identification, distribution and life history. Prerequisite: VPAR 483, 484 or equivalent.

603. Host — Helminth Relationship. (2-3). Credit 3. Behavior, physiology, ecology, genetics, host relationships, host specificity, biological relationships, peculiarities and research potential of helminth parasites of veterinary importance. Prerequisites: VPAR 601, or BIOL 627 or equivalent.

604. Parasitic Protozoa. (3-3). Credit 4. Taxonomy, morphology, life cycle, physiology, distribution, genetics, host relations, methods and diagnosis concerned with protozoan parasites affecting vertebrates including humans. Prerequisite: VPAR 484 or BIOL 108 or 438 or ENTO 208 or equivalent.

605. Immunoparasitology. (3-0). Credit 3. Immunologic processes involved in natural and acquired resistance to parasitic infections. Prerequisites: VPAR 487 and VTMI 640 or equivalents.

685. Problems. Credit 1 to 4 each semester. Special problems concerned with parasites of domestic animals or poultry. Prerequisites: VPAR 601 or equivalent; approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis.

DEPARTMENT OF VETERINARY PATHOLOGY

L. G. Adams, J. F. Edwards, P. F. Frelier, R. A. Green, K. R. Pierce* (Head), W. K. Read, J. A. Shadduck, R. Smith III, B. A. Sowa, G. Stoica, R. W. Storts, J. W. Templeton, B. R. Weeks, M. S. Whitney, J. E. Womack

*Graduate Advisor

There is no department requirement for foreign languages. These are considered in the same status as other supplementary areas of study, to be included when indicated by the individual needs of students.

(VPAT)

601. Basic Pathology. (3-3). Credit 4. Pathologic processes occurring in diseased cells, tissues and organs of animals; their pathogenesis and morphologic manifestations. Prerequisites: Courses in gross and microscopic mammalian anatomy and physiology and approval of instructor.

640. Mechanisms of Disease. (3-0). Credit 3. Concepts of pathogenesis of disease in animals. Prerequisite: D.V.M. degree or approval of department head.

641. Systemic Pathology I. (2-4). Credit 4. Disease manifestations in special organs and tissues and interrelations of pathologic processes in individual and functionally related organs. Prerequisite: D.V.M. degree or equivalent.

642. Mechanisms of Metabolic Disease. (3-0). Credit 3. Characteristics and mechanisms of diseases caused either by deficiency, imbalance, excess of specific nutrients or chemicals, or by regulatory disturbances of metabolism. Prerequisite: D.V.M. degree or approval of department head.

643. Applied Pathology. Credit 1 or more each semester. Application of information and concepts of anatomic and clinical pathology to the diagnosis of animal disease. Gross pathological changes observed in necropsy are correlated with and corrected by histopathologic observations. Confirmatory methods of clinical pathology and laboratory medicine used where indicated. Prerequisite: D.V.M. degree or equivalent.

645. Neoplastic Diseases. Credit 1 to 8. Theoretical, histopathological and clinical aspects of neoplasia. Diagnosis of neoplastic and related conditions in all species. Prerequisite: D.V.M. degree or equivalent.

650. Neuropathology of Animals. Credit 1 to 4. Pathology and pathogenesis of diseases of the central and peripheral nervous systems. Interpretation of gross and microscopic lesions of the nervous system associated with disease processes. Prerequisite: D.V.M. degree or equivalent.

651. Systemic Pathology II. (1-3) Credit 2. Continuation of VPAT 641. Disease manifestations in special organs and tissues and interrelations of pathologic processes in individual and functionally related organs. Prerequisite: VPAT 641.

653. Diseases of Laboratory Animals. (2-2). Credit 3. Pathology and pathogenesis of spontaneous infectious, parasitic, metabolic and neoplastic diseases of laboratory animals. Prerequisite: VMID 922 or equivalent.

681. Seminar. (1-0). Credit 1. For graduate and special students in veterinary pathology. Presentation and discussion of special topics and research data concerning pathology and pathogenesis of diseases. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 4 each semester. Advanced special problems concerned with pathogenesis and pathology of disease. Prerequisite: Approval of department head.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of veterinary pathology. May be repeated for credit.

690. Theory of Research. (3-0). Credit 3. Theory and design of research related to current biomedical problems especially those involving study of animal disease. Philosophical perspectives underlying historical advances in research pertaining to the study, prevention and treatment of disease. Prerequisite: Graduate classification.

691. Research. Credit 1 or more each semester. Research reported by writing of thesis or dissertation as partial requirement for M.S. or Ph.D. degree.

DEPARTMENT OF VETERINARY PHYSIOLOGY AND PHARMACOLOGY

M. S. Amoss, Jr., J. G. Anderson, Jr., E. M. Bailey, Jr., S. A. Brown, D. L. Busbee, B. J. Camp, L. D. Claborn, D. E. Clark, D. R. Clark, N. P. Clarke, D. R. Gross, D. Hightower, D. M. Hood, J. F. Hunter, G. W. Ivie, D. H. Jones, H. L. Kim, D. T. Kochevar, D. C. Kraemer, J. D. McCrady* (Head), A. A. Price, L. D. Rowe, S. H. Safe, S. W. J. Seager, D. A. Witzel

*Graduate Advisor

Graduate programs leading to the master of science and doctor of philosophy degrees in physiology or toxicology are designed to prepare the graduate for research, teaching and other related areas. Faculty specialty areas include physiology, pharmacology, toxicology, endocrinology, reproduction, bioelectronics, biochemistry, biomathematics, bionucleonics and nuclear medicine. A broad program of research in many areas including toxicology, cardiovascular physiology, endocrinology, reproduction and nuclear medicine is available.

There is no departmental requirement for foreign languages. These are considered in the same status as other supplementary areas of study to be included when indicated by the individual needs of students.

(VTPP)

601. Physiology. (3-3). Credit 4. Introduction to physiology, physiochemical basis of cellular physiology, dynamics of nerve and muscle, characteristics of blood and cardiovascular physiology. Prerequisites: Undergraduate level courses in biology, organic chemistry and vertebrate anatomy.

602. Physiology. (3-3). Credit 4. Respiratory physiology, renal function, acid-base balance, mechanisms of digestion, absorption and excretion, metabolism and energy exchange, liver function, neurophysiology, special senses, neuroendocrine control, physiology and biochemistry of endocrine secretions and reproductive processes. Prerequisite: VTPP 601 or equivalent.

603. Endocrinology. (3-3). Credit 4. Physiology, biochemistry and pharmacology of the endocrines. Laboratory emphasizes a number of classical experiments with clinical application. Prerequisites: Basic courses in morphology, physiology and biochemistry.

607. Pharmacology. (3-3). Credit 4. Pharmacokinetic and pharmacodynamic principles of pharmacology; absorption, distribution, excretion and dose-response relationships. Prerequisites: VTPP 601 or equivalent; basic statistics course.

608. Systems Pharmacology. (3-3). Credit 4. Effects of drugs on the major organ systems of animals. Prerequisite: VTPP 607.

613. Cardiovascular Physiology. (3-3). Credit 4. Cardiovascular physiology using highly specialized techniques and equipment. Prerequisite: VTPP 602 or 611 or equivalent.

614. Gastrointestinal and Ruminant Physiology. (3-3). Credit 4. Detailed physiologic study of digestion in monogastric and ruminating domestic animals. Prerequisite: VTPP 601 or equivalent.

615. Physiology of the Kidney and Body Fluids. (3-0). Credit 3. Kidney and body fluids. Prerequisite: VTPP 601 or equivalent.

616. Neurophysiology. (3-0). Credit 3. Physiology of nervous system. Prerequisite: VTPP 602 or equivalent.

617. Respiratory Physiology. (2-3). Credit 3. Gas exchange, regulation of respiration, response to various gases, reflexes associated with respiration and the mechanical factors of breathing in health and disease. Pulmonary circulation and non-respiratory functions of the lungs. Prerequisites: VTPP 601 and 602 or equivalent.

618. Gamete and Embryo Physiology. (2-2). Credit 3. Physiology of gametes and preimplantation embryos in livestock, laboratory animals and wildlife; embryo transfer, in-vitro fertilization, cryopreservation, nuclear transfer, chimera formation, gene transfer. Prerequisite: ANSC 433.

619. Molecular Endocrinology. (3-0). Credit 3. Structure-function relationships of hormones, their receptors and biologic activities. Prerequisites: VTPP 603 or BIOL 649, BICH 410 or equivalent and approval of instructor.

620. Bionucleonics. (3-3). Credit 4. Applications of nuclear science to quantitation of physiologic parameters, visualization of organs and lesions, and determination of kinetic phenomena in clinical and research animals. Prerequisites: Graduate classification, VTPP 601 or equivalent, and/or approval of instructor.

621. Mammalian Radiation Biology. (2-0). Credit 2. Biological effects resulting from exposure to ionizing radiation at the subcellular, cellular, tissue, organ and organism level. Prerequisite: BIOL 220 or VTPP 323 or equivalent, NUEN 402 or equivalent.

622. Veterinary Nuclear Medicine. (2-0). Credit 2. Clinical uses of veterinary nuclear medicine; nuclear medicine procedures applicable to major organ systems; considerations for the referring veterinarian. Prerequisite: D.V.M. or M.D.

624. Surgery for Physiologists. (2-6). Credit 4. Physiological applications of experimental mammalian surgery. Surgical procedures used in the preparation of classical experiments in physiology. Prerequisites: Approval of instructor.

625. Physiological Measurements. (3-3). Credit 4. Modern methods of measurement and recording of physiological phenomena in the living body as related to diagnosis, research and teaching. Prerequisite: ELEN 630 or equivalent.

627. Toxicology. (3-3). Credit 4. Absorption, kinetics and excretion of foreign compounds including methods of assessing effects of toxicants and of inorganic compounds on a mammalian system. Prerequisites: BICH 411; VTPP 601 or equivalent.

628. Toxicity Testing Concepts. (1-6). Credit 3. Toxicity testing for compliance with federal drug and chemical laws. Prerequisite: VTPP 627.

629. Toxic Plants and Biotoxins. (2-3). Credit 3. Indigenous and introduced plants toxic to animals and humans. Vertebrate and invertebrate toxins. Field trips for plant identification. Prerequisites: VTPP 627; approval of instructor.

631. Instrumentation in Toxicological Analysis. (2-6). Credit 4. Introduction to analytical methods in toxicology; procedures using modern laboratory instruments. Prerequisites: CHEM 316, 319; VTPP 601 or equivalent.

632. Metabolic and Detoxication Mechanisms. (3-0). Credit 3. Fate of foreign compounds; their inhibitory and antagonistic action toward normal metabolic processes of the animal body. Prerequisites: BICH 603; approval of instructor and department head.

633. Natural Products Toxicology. (3-0). Credit 3. Occurrence, isolation, characterization and toxicity of natural toxicants in human and animal foodstuffs of plant, animal and microbial origin. Prerequisite: VTPP 627; B.S. degree or approval of instructor.

634. Industrial and Environmental Toxicology. (3-0). Credit 3. Hazards encountered from poisons contaminating environment. Prerequisite: Approval of instructor and department head.

639. Genetic and Molecular Toxicology. (2-3). Credit 3. Theoretical and practical approach to a number of *in vitro* and *in vivo* microbial and mammalian systems involved in short term testing for environmental and industrial toxicants. Prerequisites: VTPP 627; graduate course in microbiology; approval of instructor.

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work in physiology and related subjects. Prerequisite: Approval of department head.

685. Problems. Credit 1 to 4 each semester. Problems in physiology, pharmacology or toxicology. Prerequisite: D.V.M. degree or appropriate specialized training.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of veterinary physiology and pharmacology. May be repeated for credit. Prerequisite: Approval of instructor.

690. Theory of Research. (3-0). Credit 3. Introduction to the theoretical and methodological principles of conducting original research in the physiologic and toxicologic sciences. Problems in various specialized research areas discussed. Prerequisite: Graduate classification.

691. Research. Credit 1 or more each semester. Original investigations in veterinary physiology, pharmacology or toxicology to be submitted by writing of thesis or dissertation as partial fulfillment for M.S. or Ph.D. degree. Prerequisite: Approval of department head.

DEPARTMENT OF VETERINARY PUBLIC HEALTH

A. B. Childers, Jr., R. P. Crawford, N. D. Heidelbaugh* (Head), G. N. Joiner, D. N. McMurray, T. D. Phillips, L. H. Russell, Jr.

*Graduate Advisor

Our mission is to develop and distribute veterinary knowledge for the protection and promotion of human health.

The department offers the following degree programs:

Epidemiology	M.S.
Laboratory animal medicine	M.S.
Food science and technology	M.S. and Ph.D.
Toxicology	M.S. and Ph.D.
Veterinary public health	M.S. and Ph.D.
Veterinary medical sciences	M.S. and Ph.D.

The department's principal teaching and research activities involve the study of: a) **animal control** consisting of a multidisciplined approach to adequately reduce adverse public health implications resulting from pet, stray, feral, and exotic animals; b) **comparative medicine** including research in animal systems which are comparable to human systems in such areas as toxicology, environmental and occupational medicine, disease prophylaxis, immunology, genetics, teratology, mutagenicity, carcinogenicity, disease occurrence and aging; c) **epidemiology** of acute and chronic diseases (infectious and noninfectious) with emphasis on those diseases and disease processes common to humans and animals; d) **food safety** including the means to develop and implement technological and/or regulatory practices designed to protect and/or improve aspects of human food and/or animal feed which can influence public health and/or animal health; e) **laboratory animal management** emphasizing the study of management practices, regulations, humane concerns, public relations, and costs/benefits which pertain to the use of animals in research; f) **preventive medicine** emphasizing methods to protect and improve human and animal health through development of new veterinary knowledge to defend populations against disease; g) **public health practice** involving the protection and improvement of the health of people and animals by environmental, occupational and human health programs.

Graduate degree programs are prepared on an individual basis by the student's graduate committee in consultation with the student. In developing such individual graduate degree programs, emphasis is placed on attaining a good match between the student's preferences and what is judged to be an area of opportunity in the rapidly changing field of public health practice.

The graduate programs in epidemiology, laboratory animal medicine, food science and toxicology are interdepartmental. A minimum of 32 semester hours and a thesis are required for the M.S. degree. A non-thesis M.S. degree option is available for students who have broad academic backgrounds and goals. Six semesters of full-time graduate study (96 semester hours) beyond the B.S. degree and a dissertation are part of the minimum requirements of the Ph.D. degree.

(VTPH)

601. Food Hygiene. (3-4). Credit 4. Causes of spoilage, detection of adulterants and regulations governing the inspection of foods of animal origin. Prerequisite: Graduate classification.

607. Applied Epidemiology. (3-3). Credit 4. Application of epidemiologic concepts to the study of disease occurrence. Descriptive epidemiologic methods in the study of diseases. Prerequisite: Graduate classification.

618. Food Toxicology. (3-0). Credit 3. The study of food additives, chemical and microbial contaminants, and naturally occurring toxins associated with foods. Prerequisite: Graduate classification.

619. Food Toxicology II. (3-0). Credit 3. Public health implications of toxic factors in foods, their source, nature, occurrence and distributions; emphasis on mycotoxins including their isolation, detection, identification and toxicology; study of state-of-the-art food safety research techniques. Prerequisite: VTPH 618.

620. Humane, Public Health, and Regulatory Aspects of Animal Use. (1-0). Credit 1. Emphasizes thoughtful and humane use of animals in teaching, research and service; human and animal health benefits of biomedical research; governmental policies, regulations, public health implications, management practices and public relations pertaining to animal use in research and teaching.

632. Public Health Concepts. (3-0). Credit 3. History, organization and administration of local, state, national and international health agencies; detailed descriptions of selected public health programs; concepts of health and disease; introduction to control of selected communicable diseases in man.

633. Animal Diseases in Comparative Medicine. (3-0). Credit 3. Selected diseases transmitted between animals and humans including geographic distribution, epidemiology, clinical signs, prevention and control of zoonotic diseases. Prerequisite: Graduate classification.

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work and research in the field of veterinary preventive medicine, public health and laboratory animal medicine. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 6 each semester. Problems course in veterinary public health. Prerequisite: Approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of veterinary public health. May be repeated for credit. Prerequisites: Approval of instructor and department head.

691. Research. Credit 1 or more each semester. Research reported by writing of thesis or dissertation as partial requirement for M.S. or Ph.D. degree. Prerequisite: Approval of department head.

DEPARTMENT OF VETERINARY SMALL ANIMAL MEDICINE AND SURGERY

J. R. August* (Head), B. V. Beaver, H. W. Boothe, Jr., D. K. Chester, T. W. Fossom, E. D. Gage, S. M. Hartsfield, M. R. Herron, H. P. Hobson, D. A. Hulse, K. W. Knauer, G. E. Lees, W. J. Roenigk, K. S. Rogers, M. D. Willard

*Graduate Advisor

(VSAM)

603. Surgery. Credit 1 to 8 each semester. Special surgery of domestic animals. May be taken more than once but not to exceed 8 hours of credit toward a graduate degree. Prerequisite: D.V.M. degree or approval of department head.

632. Veterinary Dermatology. (4-0). Credit 4. Pathogenesis, diagnosis and therapy of integumentary diseases of domestic animals; diseases of infectious, nutritional, neoplastic, endocrinologic and immunologic influence. Prerequisite: D.V.M. degree or approval of the department head.

634. Veterinary Anesthesiology. (2-0). Credit 2. Types of anesthesia, anesthetic agents and their adjuncts, methods of administration, anesthetic complications, artificial ventilation, control of acid-base balance, evaluation of clinical cases. Prerequisite: D.V.M. degree or approval of instructor.

636. Veterinary Ophthalmology. (3-0). Credit 3. Large and small animal ophthalmic diseases; diagnosis, instrumentation, therapy, surgical approaches and complications. Prerequisite: D.V.M. degree or approval of the department head.

637. Small Animal Nephrology and Urology. (2-0). Credit 2. Diseases of the urinary system of dogs and cats, including comparison with urinary disorders affecting other mammalian species; emphasizes development and application of a thorough understanding of pathogenic mechanisms as a basis for formulating diagnostic strategies and therapeutic interventions. Prerequisite: D.V.M. degree or approval of the department head.

669. Veterinary Clinical Cardiology. (2-0). Credit 2. Diagnosis and treatment of clinical cardiac disease in domestic animals; special techniques such as phonocardiography, cardiac catheterization and angiocardiography. General principles of clinical cardiology as applied to all species of animals, as well as specific clinical case presentations. Prerequisite: D.V.M. degree or approval of department head.

681. Seminar. (1-0). Credit 1. Current scientific work in medical and surgical fields in and related to small animal medicine and surgery. May be repeated for credit. Prerequisites: D.V.M. degree and approval of department head.

685. Problems. Credit 1 to 8 each semester. Original investigations of problems in field of small animal surgery, therapeutics or radiology. Prerequisite: D.V.M. degree and approval of instructor.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of small animal medicine or surgery. May be repeated for credit. Prerequisites: D.V.M. degree and approval of instructor.

691. Research. Credit 1 or more each semester. Research for thesis.

DEPARTMENT OF WILDLIFE AND FISHERIES SCIENCES

C. E. Adams, D. V. Aldrich, K. A. Arnold, J. W. Bickham*, J. T. Davis, L. V. DiMichele, R. B. Ditton, J. R. Dixon, N. O. Dronen, L. J. Folse, Jr., D. M. Gatlin III, J. R. Gold, W. E. Grant, R. L. Honeycutt, S. K. Johnson, W. H. Kiel, Jr., W. G. Klussmann, A. M. Landry, Jr., A. L. Lawrence, T. L. Linton, J. D. McEachran, B. R. Murphy, W. H. Neill, J. M. Packard, S. M. Ray, K. L. Risenhoover, D. J. Schmidly (Head), N. J. Silvy, R. D. Slack, R. K. Strawn, M. W. Weller

*Graduate Advisor

Graduate programs of study and research lead to the M.Agr. degree in wildlife science or fisheries science, and M.S. and Ph.D. degrees in wildlife and fisheries sciences. These programs prepare students for careers with academic institutions, government agencies and private business/industry. Studies in environmental conservation and education are available to those students interested in preparing themselves for public service in a number of fields other than research and management. The non-thesis M.Agr. and M.S. programs are designed to give students broad academic training combined with practical experience to develop problem-solving and management skills. The M.S. (thesis option) and Ph.D. degrees require a strong background in the basic and applied agricultural and life sciences, particularly as they relate to whole-organism biological systems. The two latter degrees involve intensive research, and the resulting thesis or dissertation must demonstrate a superior knowledge and understanding of the subject area.

Research activities in the department involve vertebrates, invertebrates and plants, and span the broad fields of wildlife ecology and management, fisheries ecology and management, aquaculture, biodiversity and systematics, conservation

education/museum science and the human dimensions of wildlife and fisheries resources/management. Research in these fields is supported by disciplinary expertise in community ecology, evolutionary biology, resource sociology, animal behavior, physiology, animal diseases and parasitology, bioenergetics, nutrition, genetics, and systems analysis and modeling.

Facilities for research and graduate education include over forty laboratories with modern and sophisticated scientific instrumentation; the Texas Cooperative Wildlife Collection, which is among the largest collections of animals and genetic tissues in the New World; an Aquaculture Research Center and Fish Hatchery (laboratory and ponds) devoted to teaching and research on production of fish and invertebrate organisms for food and sport fishing; and a Wild Animal Pen Facility where captive animal species are used in studies of animal behavior and communication. Provisions for research in marine ecology and mariculture are available at Texas A&M University in Galveston, and field studies may be conducted at the off-campus research and extension centers of the Texas Agricultural Experiment Station. Texas A&M University is a member of the Organization for Tropical Studies and graduate students are eligible to apply for usage of laboratory and field facilities in Costa Rica. In addition, some faculty members in the Department of Wildlife and Fisheries Sciences have appointments on the interdisciplinary faculties of genetics and animal nutrition, and graduate students are eligible to seek degrees in those areas. The department also encourages interdisciplinary research topics with other departments in the Colleges of Agriculture and Life Sciences, Science, Geosciences and Veterinary Medicine.

Graduate study programs in wildlife and fisheries sciences normally require some breadth in several disciplines, which differ among courses of study and are dependent on candidate backgrounds. Support course content in degree programs is tailored to the background and educational goals of each degree candidate in consultation with his or her graduate advisory committee. There are no foreign language requirements for any graduate degree program (unless set by the student's Advisory Committee).

(WFSC)

600. Field and Laboratory Methods. (1-6). Credit 3. Experience in field studies, organizing field notes, collecting and preserving vertebrate animals for teaching and museum purposes. Methods for maintaining live animals and for identifying animals collected. Training in preparing skeletons, corrosion models, cleared specimens and in plastic embedding. Prerequisite: Eighteen hours of biological sciences or approval of instructor.

601. Vertebrate Systematics. (1-6). Credit 3. Theory and practice of biological systematics and taxonomy; historical development of discipline, mechanisms of speciation, the origin of higher categories and major taxonomic philosophies (numerical taxonomy, phylogenetic systematics and evolutionary systematics). Theory involved in the study of vertebrates.

602. Vertebrate Cytosystematics. (2-3). Credit 3. Application of modern cytogenetic techniques to the study of taxonomy and evolutionary biology with special emphasis on vertebrates. Prerequisite: GENE 603, WFSC 601 or approval of instructor.

603. Vertebrate Ecology. (2-3). Credit 3. Ecology of the individual, population and ecosystem; epistemology of major ecological concepts. Theory evolved in the study of vertebrates.

604. Wildlife and Fisheries Systems Analysis. (2-3). Credit 3. Systems analysis techniques applied to problems in wildlife and fisheries sciences. Philosophical and technical discussion of the conceptualization, formulation, evaluation and use of models. Prerequisite: STAT 302 or equivalent; MATH 230 or equivalent; or approval of instructor.

605. Systematic Ichthyology. (2-3). Credit 3. Functional morphology, phylogeny, ecology and zoogeography of fishes of the world. Relating adaptive morphology and ecology to phylogeny of fishes.

606. Systematic Herpetology. (2-3). Credit 3. Distribution, evolution, speciation and new systematics of amphibians and reptiles; extensive field studies of local problem groups and philosophy and role of herpetology as a science. Prerequisite: WFSC 315.

607. Systematic Ornithology. (2-3). Credit 3. Living birds of the world; diversity, radiation, adaptation, distribution and past history. Contrasts both between the taxa and between the continental avifaunas. Field trips required for which departmental fees may be assessed to cover costs. Prerequisites: WFSC 402 or equivalent experience in ornithology.

608. Wildlife and Fisheries Law Administration. (3-0). Credit 3. State and federal laws, regulations and court decisions; state and federal jurisdiction over wildlife and fisheries, legal research methods, and the administration and enforcement of laws by wildlife agencies. Prerequisite: Graduate classification.

609. Wildlife Research Methods. (3-0). Credit 3. Research methods applied to wildlife management and related subjects. Review of the scientific method; research proposals and data analysis.

610. Systematic Mammalogy. (2-3). Credit 3. Distribution, speciation and systematics of recent mammals of world; research methods and techniques used in systematic investigations of mammals. Prerequisite: Approval of instructor.

611. Estuarine Ecology. (3-3). Credit 4. Principles governing the relationships of estuarine organisms to their environment. Productivity, adaptations to environment, community structure and factors affecting the distribution and abundance of biota. Prerequisites: Invertebrate zoology and ichthyology or approval of instructor.

613. Shore and Estuarine Fishes. (0-9). Credit 3. Field survey of fishes found in shallow-water habitats along the Gulf of Mexico. Extensive collecting trips made; ecological data taken; and collected specimens identified, counted and evaluated in laboratory. Prerequisite: WFSC 311 or approval of instructor.

614. Biological Limnology. (2-3). Credit 3. Theory and application of procedures for obtaining reliable quantitative measurements of aquatic populations. Statistical approaches dictated by the nature of the distributions and basic optimization procedures are reviewed, leading to studies of the design of sampling programs under various statistical and resource constraints.

615. Mariculture. (3-3). Credit 4. Environmental, physiological, behavioral, legal and economic factors which determine the success of efforts to cultivate saltwater species having economic importance. Practices employed in various parts of the world to produce fishes, molluscs and crustaceans. Prerequisites: Ichthyology and invertebrate zoology or approval of instructor.

616. Physiological Ecology of Vertebrates. (3-4). Credit 4. Effects and limitations of temperature, photoperiod and other environmental factors on the distribution and abundance of animals. Comparative behavioral and physiological adjustments to environment as an evolutionary response. Students will be expected to develop and execute a laboratory investigation in an appropriate subject area. Emphasis on terrestrial vertebrates in 616T; emphasis on aquatic vertebrates, particularly fishes, in 616A.

618. Dynamics of Fish Populations. (2-2). Credit 3. Principles and practices of stock identification, recruitment, growth, abundance, mortality and regulation and yields of fisheries stocks. Prerequisites: WFSC 311; MATH 230; STAT 651; or approval of instructor.

619. Analytical Procedures in Fisheries. (2-2). Credit 3. Theory and application of qualitative and quantitative analytical procedures in fisheries research and management. Population and community parameters useful in evaluation of management techniques and other environmental alterations. Prerequisites: WFSC 410 or equivalent; STAT 651.

620. Vertebrate Ethology. (3-2). Credit 4. Mechanisms and control of vertebrate behavior in an ecological context, as shaped by natural selection; classical and current theories regarding the genetic basis, development, specialized sensory systems and organization of responses in changing environment; laboratory emphasizes observational skills and quantitative analysis of behavior occurring in natural settings.

621. Communicative Behavior in Animals. (2-0). Credit 2. Theory of communication; classification of the corresponding behaviors; message and meaning; unaddressed and addressed communication; adaptations of sender and recipient; intra- and inter-specific communication; communication in selected vertebrate groups. Prerequisites: WFSC 422 and 620 or equivalent courses in ethology.

622. Behavioral Ecology of Vertebrates. (3-0). Credit 3. Behavior of vertebrates in response to ecological factors. Use of space and other resources including habitat selection, foraging strategies, mating systems and the overall organization of reproduction emphasized. Prerequisite: WFSC 403 or equivalent.

624. Dynamics of Wild Animal Populations. (2-3). Credit 3. Principles, models and methods for analysis of population dynamics of wild animals; analysis of contemporary research emphasizing theory and its uses in evaluation and management of wild animal populations. Laboratory emphasizes mathematical, statistical and computer modeling of population phenomena. Prerequisites: MATH 230, STAT 651, upper level ecology; or approval of instructor. Cross-listed with ENTO 624.

625. Evolutionary Mechanisms of Vertebrates. (3-0). Credit 3. Genetic mechanisms of community structure with major emphasis at or above the organismic level of organization; neo-Darwinian theory compared with alternative evolutionary hypotheses; evolution of vertebrates in relation to neo-Darwinian and other hypotheses. Prerequisite: WFSC 603, GENE 625 or approval of instructor.

626. Microcomputer Simulation in Wildlife Ecology. (2-3). Credit 3. Methods of modelling processes of wildlife ecology using microcomputers and a high-level programming language; use of modular program design, complex data structures and suitable algorithms to design, implement, simulate and analyze ecological models. Prerequisites: MATH 230, STAT 651, 3 hours computer programming, a course in modelling; or approval of instructor.

628. Wetland Ecology. (2-3). Credit 3. Wetlands as ecological systems that are prime habitats for wildlife and fish; geomorphology, hydrology, limnology, plant and animal communities, and human use and management. Prerequisite: WFSC 403 or RASC 316 or 417 or BIOL 459 or equivalent.

629. Collection Management. (2-3). Credit 3. Collection and maintenance of biological materials for use in teaching, research and display; procedures, physical storage techniques, electronic data processing systems, ethics and laws pertaining to use of collections. Prerequisite: Approval of instructor.

630. Museum Programming. (3-0). Credit 3. Gathering, analysis and presentation of information leading the use of museums, nature centers, refuges, zoos and other outdoor interpretive facilities as teaching resources. Short term and extended field trips.

681. Seminar. (1-0). Credit 1 each semester. Important current developments in wildlife or fisheries fields with special reference to literature.

684. Professional Internship. Credit 1 to 16 each semester. On-the-job training in fields of wildlife and fisheries sciences. Prerequisite: Graduate classification in wildlife and fisheries sciences. (Students holding fellowships, scholarships and those involved in long internships are required to register for more than 4 hours per semester.)

685. Problems. Credit 2 to 6 each semester. Individual study and research on selected problem approved by instructor and graduate advisor. Credit adjusted in accordance with requirements of each individual case. Prerequisite: Approved proposal.

689. Special Topics in . . . Credit 1 to 4. Special topics in wildlife ecology, fisheries ecology, vertebrate systematics, evolutionary biology of vertebrates and conservation education. May be repeated for credit.

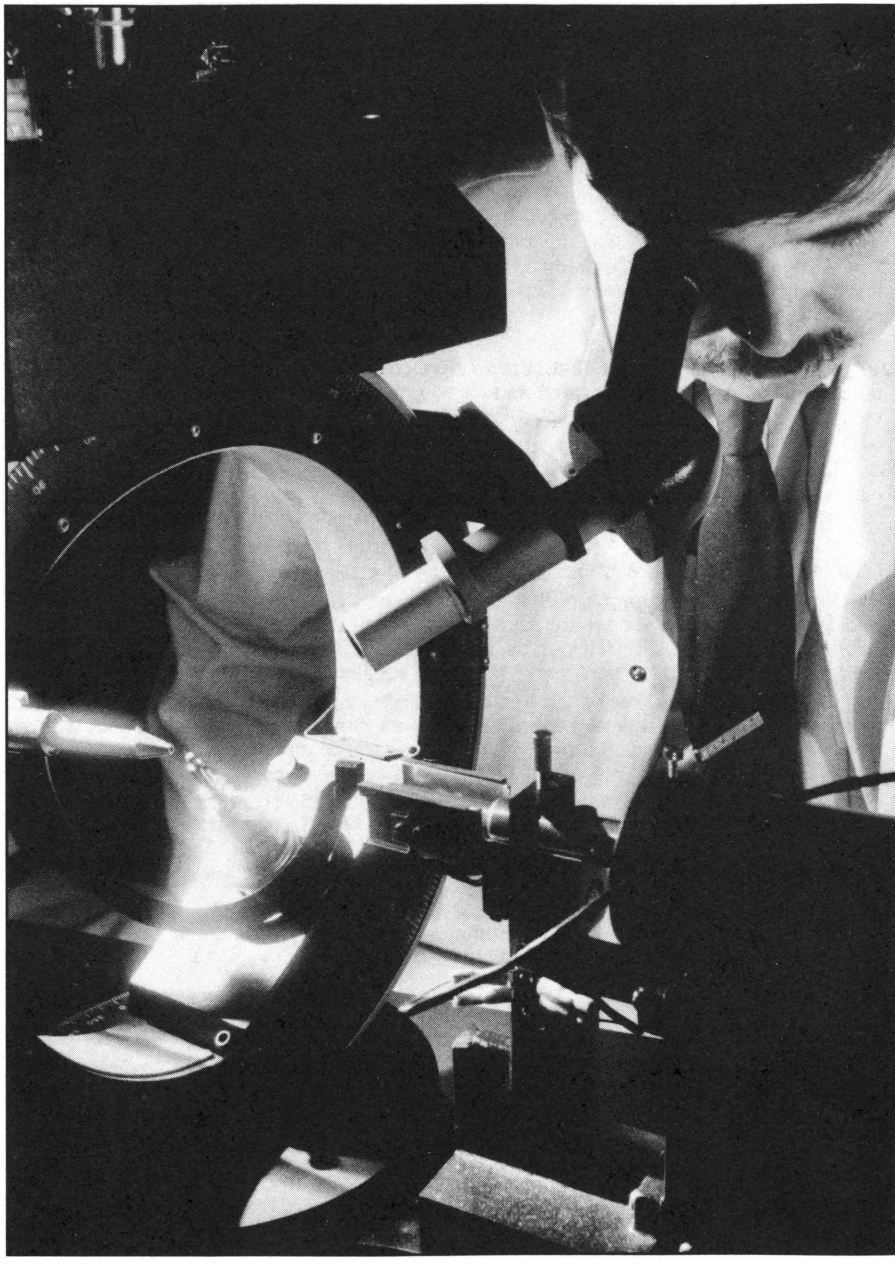
690. Theory of Research. (2-0). Credit 2. Theory, design, analysis and communication of research in wildlife and fisheries sciences. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester. Original research on selected wildlife problem to be used in thesis or dissertation.

ZOOLOGY

(See Biology)

TEXAS A&M UNIVERSITY



GRADUATE FACULTY

(Listings of degrees and rank correct as of October 1, 1988. Listings of Graduate Faculty membership correct as of March 1989. Figures in parentheses indicate date of first appointment on the University staff and date of appointment to present position, respectively.)

Abello, James, *Assistant Professor, Department of Computer Science.* (1988) B.S., University of Santiago de Cali (Colombia), 1976; M.S., University of Puerto Rico, 1978; M.S., University of California, Santa Barbara, 1983.

Abelson, Michael A., *Associate Professor of Management.* (1980, 1986) B.A., Pennsylvania State University, 1972; M.A., Central Michigan University, 1975; M.B.A., Pennsylvania State University, 1980; Ph.D., 1981.

Abernathy, John R., *Associate Professor of Agronomy, TAMU Agricultural Research and Extension Center (Lubbock).* (1980) B.S., Oklahoma State University, 1967; M.S., 1969; Ph.D., University of Illinois, 1972.

Aberth, Oliver G., *Professor of Mathematics.* (1970) B.S., City College of New York, 1950; M.S., Massachusetts Institute of Technology, 1951; Ph.D., University of Pennsylvania, 1962.

Abu-Amara, Hossame, *Assistant Professor, Department of Electrical Engineering.* (1989) B.S., University of California, Berkeley, 1983; M.S., University of Illinois, Champaign-Urbana, 1985; Ph.D., 1988.

Abur, Ali, *Assistant Professor, Department of Electrical Engineering.* (1985) B.S., Middle East Technical University (Turkey), 1979; M.S., Ohio State University, 1981; Ph.D., 1985.

Adair, Thomas W., III, *Professor of Physics.* (1966, 1978) B.S., Texas A&M University, 1957; M.A., Rice University, 1960; Ph.D., Texas A&M University, 1965.

Adams, Clark E., *Associate Professor of Wildlife and Fisheries Sciences.* (1981, 1987) B.S., Concordia Teachers College, 1964; M.S., University of Oregon, 1966; Ph.D., University of Nebraska, 1973.

Adams, Emory Temple, Jr., *Professor of Chemistry.* (1969, 1976) B.A., Rice University, 1949; M.S., Baylor College of Medicine, 1952; Ph.D., University of Wisconsin, 1962.

Adams, Henry R., *Visiting Member, Department of Veterinary Physiology and Pharmacology.* (1977) B.S., Texas A&M University, 1965; D.V.M., 1966; Ph.D., University of Pittsburgh, 1972.

Adams, Leslie Garry, *Professor of Veterinary Pathology.* (1969, 1978) B.S., Texas A&M University, 1963; D.V.M., 1964; Ph.D., 1968; Diplomate, American College of Veterinary Pathologists, 1970.

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Wolfe, Christopher J., *Assistant Professor of Accounting.* (1985) B.S., Utah State University, 1977; M.B.A., Kent State University, 1981; D.B.A., 1984; C.P.A., Ohio, 1984.

Wolfe, Mary Leigh, *Assistant Professor, Department of Agricultural Engineering.* (1986) B.S., Virginia Polytechnic Institute and State University, 1979; M.S., 1982; Ph.D., University of Minnesota, 1986.

Wolfenden, Alan, P.E., *Professor, Department of Mechanical Engineering.* (1982, 1984) B.Sc., University of Liverpool (England), 1961; Ph.D., 1965; D.Sc., 1986.

Wolinsky, Fredric D., *Professor of Sociology and of Humanities in Medicine.* (1985, 1987) B.A., Friends University, 1972; M.A., Drake University, 1974; Ph.D., Southern Illinois University, 1977.

Wolken, Lawrence C., *Distinguished Lecturer in Finance.* (1978, 1988) B.A., University of Missouri-Columbia, 1967; M.S., Texas A&M University, 1968; Ph.D., 1972.

Wolter, Jan D., *Assistant Professor, Department of Computer Science.* (1988) B.S.E., University of Michigan, 1981; M.S.E., 1983; Ph.D., 1988.

Womack, James E., *Professor of Veterinary Pathology and of Genetics and Holder of the W. P. Luse Endowed Professorship in Veterinary Medicine.* (1977, 1987) B.S., Abilene Christian University, 1964; Ph.D., Oregon State University, 1968.

Wong, Chi-Huey, *Professor of Chemistry and of Biochemistry and Biophysics.* (1983, 1987) B.S., National Taiwan University, 1970; M.S., 1977; Ph.D., Massachusetts Institute of Technology, 1982.

Wong, Danny S., *Visiting Associate Professor of Business Analysis and Research.* (1987) B.S., California State University, Fresno, 1972; M.S., Pennsylvania State University, 1975; Ph.D., 1978.

Wood, B. Dan, *Assistant Professor of Political Science.* (1988) B.A., University of Houston, 1976; M.A., 1985; Ph.D., 1987.

Wood, Randall D., *Professor of Biochemistry and Biophysics and of Nutrition.* (1976) B.S., University of Kentucky, 1959; M.S., 1961; Ph.D., Texas A&M University, 1965.

Wood, Wendy, *Associate Professor of Psychology.* (1982, 1987) B.S., University of Illinois, 1975; M.S., University of Massachusetts, 1978; Ph.D., 1980.

Woodcock, David Geoffrey, *Professor of Architecture.* (1962, 1982) B.A., University of Manchester (England), 1960; Dip.T.P., 1966; Chartered Architect (United Kingdom); R.I.B.A; Registered Architect, A.I.A.

Woode, Gerald N., *Professor of Veterinary Microbiology and Parasitology.* (1985) B.Vet.Med., Royal Veterinary College, London, 1961; D.V.M., University of London, 1978.

Woodfin, Thomas M., *Assistant Professor of Landscape Architecture.* (1981, 1988) B.L.A., Texas A&M University, 1976; M.L.A., Harvard University, 1981.

Woodman, Richard W., *Professor of Management.* (1978, 1988) B.S., Oklahoma State University, 1968; M.B.A., 1969; Ph.D., Purdue University, 1978.

Woods, Calvin E., P.E., *Professor, Department of Civil Engineering.* (1972) B.S., University of Houston, 1955; M.S., University of Colorado, 1959; Ph.D., University of Texas at Austin, 1964.

Woods, Donald J., *Associate Professor of Psychology.* (1987) B.S., Fordham University, 1968; M.S., Northwestern University, 1970; Ph.D., 1971.

Woods, Donald L., P.E., *Professor, Department of Civil Engineering.* (1963, 1973) B.S., Oklahoma State University, 1955; M.S., 1960; Ph.D., Texas A&M University, 1967.

Woolley, James Braden, *Assistant Professor of Entomology.* (1983) B.S., Oregon State University, 1977; Ph.D., University of California, Riverside, 1983.

Wootan, Charley V., *Director, Texas Transportation Institute, and Head, Transportation Economics Division, Department of Industrial Engineering.* (1966, 1976) B.S., Texas A&M University, 1950; M.S., 1951; Ph.D., 1965.

Worchel, Francis F., *Assistant Professor of Educational Psychology.* (1984, 1985) B.A., University of Virginia, 1977; M.A, 1980; Ph.D., 1984.

Worchel, Stephen, *Professor of Psychology and Head of Department.* (1983) B.A., University of Texas at Austin, 1967; Ph.D., Duke University, 1971.

Workman, Michael E., *Associate Professor, Department of Engineering Technology and Holder of the Harvey Hubbell, Inc. Professorship.* (1980, 1987) B.S., West Texas State University, 1971; M.S., Texas A&M University, 1972; Ph.D., 1985.

Wormuth, John Hazen, *Professor of Oceanography.* (1972, 1986) B.A., Hope College, 1966; Ph.D., Scripps Institution of Oceanography, 1971.

Wortman, Martin A., *Assistant Professor, Department of Industrial Engineering.* (1988) B.S., North Carolina State University, 1977; M.S., 1980; Ph.D., Virginia Polytechnic Institute and State University, 1982; Ph.D., 1988.

Wright, Steven M., *Assistant Professor, Department of Electrical Engineering.* (1988) B.S., University of Illinois, Urbana, 1980; M.S., 1981; Ph.D., 1984.

Wu, Ching H., P.E., *Professor, Department of Petroleum Engineering.* (1981) B.S., Taipei Institute of Technology, 1957; M.S., Colorado School of Mines, 1964; Ph.D., University of Pittsburgh, 1968.

Wu, Hsin-I, P.E., *Professor of Bioengineering, Department of Industrial Engineering.* (1977, 1987) B.S., Tunghai University (Taiwan), 1960; M.S., University of Missouri, 1964; Ph.D., 1967.

Wurbs, Ralph A., P.E., *Associate Professor, Department of Civil Engineering.* (1980, 1987) B.S., Texas A&M University, 1971; M.S., University of Texas at Arlington, 1974; Ph.D., Colorado State University, 1978.

Wylie, Wayne E., *Associate Professor of Health and Physical Education.* (1981, 1987) B.S., Texas A&M University, 1974; M.Ed., 1975; Ed.D., University of Tennessee, 1981.

Yancey, Thomas E., *Associate Professor of Geology.* (1980, 1984) B.A., University of California, Berkeley, 1966; M.A., 1969; Ph.D., 1971.

Yao, James T. P., *Professor and Head, Department of Civil Engineering.* (1988) B.S.C.E., University of Illinois, Urbana, 1957; M.S.C.E., 1958; Ph.D., 1961.

Yarak, Larry W., *Assistant Professor of History.* (1985) B.A., Kalamazoo College, 1972; Ph.D, Northwestern University, 1983.

Yarbrough, Stephen R., *Associate Professor of English.* (1982, 1988) B.A., Sam Houston State University, 1972; M.A., Pennsylvania State University, 1976; Ph.D., 1982.

Yasskin, Phillip B., *Assistant Professor of Mathematics.* (1982) B.A., University of Pennsylvania, 1971; M.S., 1971; M.S., University of Maryland, 1975; Ph.D., 1979.

Yeager, Danny L., *Professor of Chemistry.* (1978, 1987) B.S., University of Iowa, 1968; B.A., 1968; Ph.D., California Institute of Technology, 1975.

Young, Beverly S., *Visiting Member, Department of Educational Curriculum and Instruction.* (1975) B.A., William Penn College, 1961; M.A., University of Northern Iowa, 1965; Ph.D., University of Iowa, 1968.

Young, Brian D., *Assistant Professor, Department of Electrical Engineering.* (1988) B.S., Texas A&M University, 1984; M.S., University of Illinois, 1985; Ph.D., University of Texas at Austin, 1987.

Young, Mark Francis, *Professor of Veterinary Large Animal Medicine and Surgery.* (1960, 1975) B.S, Utah State University, 1955; D.V.M., Iowa State University, 1958; M.S., Texas A&M University, 1964.

Young, Ryland F., *Professor of Biochemistry and Biophysics and of Genetics.* (1978, 1987) A.B., Rice University, 1968; Ph.D., University of Texas at Dallas, 1975.

Youngblood, Dave Harper, *Professor of Physics.* (1967, 1976) B.S., Baylor University, 1961; M.A., Rice University, 1963; Ph.D., 1965.

Youngblood, Stuart A., *Associate Professor of Management.* (1981, 1984) B.S., Purdue University, 1972; M.S., 1973; Ph.D., 1978.

Zajicek, Jayne M., *Assistant Professor of Horticultural Sciences.* (1986) B.S., University of Nebraska, 1980; M.S., 1982; Ph.D., Kansas State University, 1986.

Zardkoohi, Asghar, *Associate Professor of Management.* (1981, 1983) B.A., Abadan Institute of Technology, 1968; M.S., Auburn University, 1973; Ph.D., Virginia Polytechnic Institute and State University, 1977.

Zellner, Ronald D., *Associate Professor of Interdisciplinary Education.* (1984) B.S., Arizona State University, 1968; M.A., 1972; Ph.D., 1973.

Zey, Mary, *Professor of Sociology and Head of Department.* (1982, 1986) B.S., Louisiana Polytechnic Institute, 1964; M.S., Florida State University, 1965; Ph.D., Louisiana State University, 1972.

Zhang, Jun, *Assistant Professor, Department of Civil Engineering and of Ocean Engineering.* (1987) M.S., Shanghai Jiao Tong University, 1981; S.M., Massachusetts Institute of Technology, 1984; Sc.D., 1987.

Zhou, Jianxing, *Assistant Professor of Mathematics.* (1987) B.S., Shanghai University of Science and Technology (P.R.C.), 1977; M.S., 1982; Ph.D., Pennsylvania State University, 1986.

Zingaro, Ralph Anthony, *Professor of Chemistry.* (1954, 1964) B.S., City College of New York, 1946; M.S., University of Kansas, 1949; Ph.D., 1950.

Zingery, Wilbur Lewis, *Senior Lecturer, Department of Agricultural Engineering.* (1975, 1986) B.S., Texas A&M University, 1950; M.S., 1951.

Zinn, Joel, *Professor of Mathematics and of Statistics.* (1981, 1983) B.A., Queen's College, 1966; M.A., University of Wisconsin, 1972; Ph.D., 1972.

Zuberer, David Alan, *Associate Professor of Agronomy.* (1978, 1983) B.S., West Virginia University, 1969; M.S., 1971; Ph.D., University of South Florida, 1976.

Zwolinski, Bruno John, *Professor of Chemistry.* (1961, 1965) B.S., Canisius College, 1941; M.S., Purdue University, 1943; M.A., Princeton University, 1944; Ph.D., 1947.

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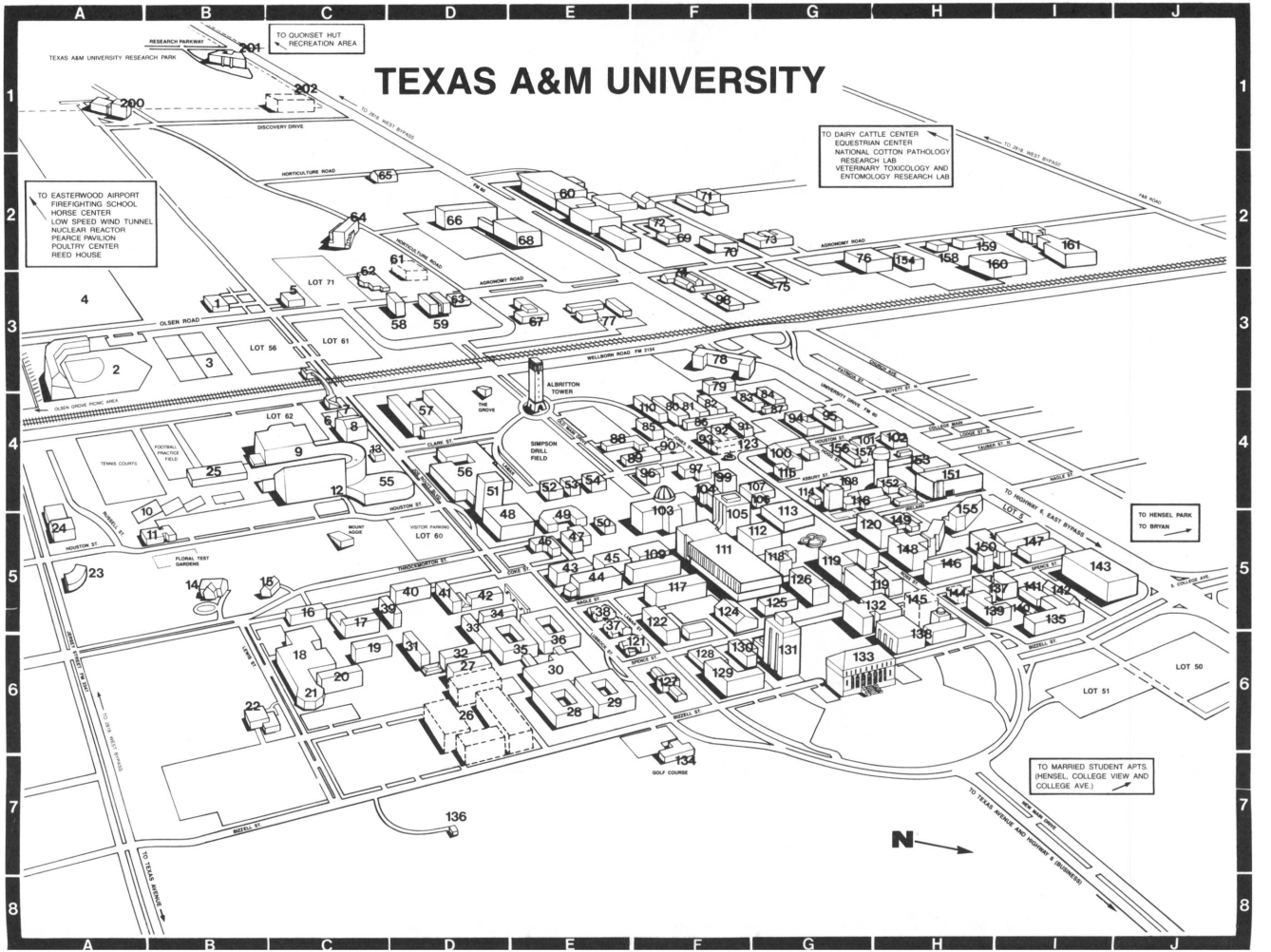
TEXAS A&M UNIVERSITY
TEXAS A&M UNIVERSITY RESEARCH PARK
RESEARCH PARKWAY
TO QUONSET HUT
RECREATION AREA
DISCOVERY DRIVE
TO EASTERWOOD AIRPORT
FIREFIGHTING SCHOOL
HORSE CENTER
LOW SPEED WIND TUNNEL
NUCLEAR REACTOR
PEARCE PAVILION
POULTRY CENTER
REED HOUSE
TO DAIRY CATTLE CENTER
EQUESTRIAN CENTER
NATIONAL COTTON PATHOLOGY RESEARCH LAB
VETERINARY TOXICOLOGY AND ENTOMOLOGY RESEARCH LAB
HORTICULTURE ROAD
AGRONOMY ROAD
OLSEN ROAD
WELLBORN ROAD FM 2154
LOT 71
LOT 56
LOT 61
LOT 62
LOT 60
LOT 50
LOT 51
OLSEN GROVE PICNIC AREA
TENNIS COURTS
FOOTBALL PRACTICE FIELD
FLORAL TEST GARDENS
MOUNT HOUSE
VISITOR PARKING
THE GROVE
ALBRITTON TOWER
SIMPSON DRILL FIELD
GOLF COURSE
TO HENSEL PARK
TO BRYAN
TO HIGHWAY 6, EAST BYPASS
TO MARRIED STUDENT APTS. (HENSEL, COLLEGE VIEW AND COLLEGE AVE.)
TO TEXAS AVENUE AND HIGHWAY 6 (BUSINESS)
TO TEXAS AVENUE
TO WEST BYPASS
N

ALPHABETICAL KEY

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107 Admissions and Records (Heaton Hall) (G-4)
65 Adriance Lab (C-2)
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13 Aggie Club, The (C-4)
77 Agricultural Engineering Shops (E-3)
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73 Agronomy Field Lab (G-2)
90 All Faiths **Chapel** (F-4)
45 Analytical Services Building (E-5)
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37 Beasley Lab (E-6)
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31 Leonard Hall-Dorm 7 (D-6)
22 Lindsey Building (B-6) (University Press)
93 McFadden Hall (F-4)
87 McInnis Hall (G-4)
141 McNew **Engineering Lab** (I-5)
68 Medical Sciences Library (E-2)
56 Memorial Student Center (D-4)
46 Military Sciences Building (Trigon) (E-5)
115 Milner Hall (G-4)
11 Moore Communications Center (B-5) (Television and Radio Stations)
83 Moore Hall (F-4)
82 Moses Hall (F-4)
28 Mosher Hall (E-6)
50 Nagle Hall (E-5)
157 Neeley Hall (G-4)
200 Ocean Drilling Program Building (A-1)
131 Oceanography and Meteorology Building (G-6)
2 Olsen **Baseball** Field (A-3)
201 One Research Park (B-1)
151 Parking Garage (H-4)
124 Pavilion, The (F-5)
3 Penberthy **Intramural** Complex (B-3)
117 Peterson Building (F-5) **(Plant Sciences** Building)
4 Physical Education Fields and Anderson Track and Field Events Complex (A-3)
159 Physical Plant/Grounds Maintenance Facility (H-2)
161 Physical Plant Offices and Shops (I-2)
102 Post Office (H-4)
14 President's Home (B-5)
149 Printing Center (H-5)
47 Psychology Building (E-5)
76 Purchasing and Stores (G-2)
89 Puryear Hall (F-4)
12 Read Building (East Kyle) (C-4)
120 Reed McDonald Building (H-5)
124 Registration Center (The Pavilion) (F-5)
66 Reynolds **Medical Sciences** Building (D-2)
144 Richardson **Petroleum Engineering** Building (H-5) (under construction)
62 Rosenthal **Meat Science and Technology** Center (C-3)
48 Rudder **Theatre** Complex (D-5)
51 Rudder Tower (D-4)
100 Sbisa Dining Hall (G-4)
95 Schuhmacher Hall (G-4)
132 Scoates Hall (G-5)
10 Smith Varsity **Tennis** Courts (B-4)
91 Special Services Building (F-4)
34 Spence Hall-Dorm 1 (D-5)
25 Steed **Research and Conditioning** Laboratory (B-4)
111 Sterling C. Evans **Library** (F-5)
133 System Administration Building (G-6)
127 TAES Annex (F-6)
129 Teague Research Center (F-6)
72 Texas Veterinary Medical Diagnostic Lab (F-2)
113 Thompson Hall (G-5)
158 Transportation Annex (H-2)
154 Transportation Center (H-2)
27 Underwood Hall (D-6)
48, 51, 56 University Center (D-4,5)
152 University **Mail** Service (H-4)
15 University Official's Home (B-5)
24 University **Police** (A-5)
16 Utay Hall-Dorm 12 (C-5)
116 Utilities Plant (G-4)
5 Utilities Plant, Satellite (C-3)
60 Veterinary Medicine Complex (E-2)
69 Vivarium (F-2)
94 Walton Hall (G-4)
17 White Hall-Dorm 10 (C-5)
19 Whiteley Hall-Dorm 9 (C-6)
135 Wisenbaker **Engineering Research** Center (I-5)
6 Wofford Cain **Pool** (C-4)
96 YMCA Building (F-4)
143 Zachry **Engineering** Center (I-5)

NUMERICAL KEY

1 Beef Cattle Center (B-3)
2 Olsen **Baseball** Field (A-3)
3 Penberthy **Intramural** Complex (B-3)
4 Physical Education Fields and Anderson Track and Field Events Complex (A-3)
5 Utilities Plant Satellite (C-3)
6 Wofford Cain **Pool** (C-4)
7 Downs **Natatorium** (C-4)
8 DeWare Field House (C-4)
9 Kyle Field (C-4)
10 Smith Varsity **Tennis** Courts (B-4)
11 Moore Communications Center (B-5) (Television and Radio Stations)
12 Read Building (East Kyle) (C-4)
13 Aggie Club, The (C-4)
14 President's Home (B-5)
15 University Official's Home (B-5)
16 Utay Hall-Dorm 12 (C-5)
17 White Hall-Dorm 10 (C-5)
18 Duncan Dining Hall (C-6)
19 Whiteley Hall-Dorm 9 (C-6)
20 Harrington Hall-Dorm 11 (C-6)
21 Adams Band Hall (C-6)
22 Lindsey Building (B-6) (University Press)
23 Clayton Williams, Jr. Alumni Center (A-5)
24 University **Police** (A-5)
25 Steed **Research and Conditioning** Laboratory (B-4)
26 Dormitories (D-6) (under construction)
27 Underwood Hall (D-6)
28 Mosher Hall (E-6)
29 Krueger Hall (E-6)
30 Commons (E-6)
31 Leonard Hall-Dorm 7 (D-6)
32 Gainer Hall-Dorm 5 (D-6)
33 Briggs Hall-Dorm 3 (D-5)
34 Spence Hall-Dorm 1 (D-5)
35 Aston Hall (D-6)
36 Dunn Hall (E-6)
37 Beasley Lab (E-6)
38 Floriculture Greenhouses (E-5)
39 Harrell Hall-Dorm 8 (C-5)
40 Lacy Hall-Dorm 6 (D-5)
41 Fountain Hall-Dorm 4 (D-5)
42 Kiest Hall-Dorm 2 (D-5)
43 Butler Building (E-5)
44 Heldenfels Hall (E-5)
45 Analytical Services Building (E-5)
46 Military Sciences Building (Trigon) (E-5)
47 Psychology Building (E-5)
48 Rudder **Theatre** Complex (D-5)
48, 51, 56 University Center (D-4,5)
49 Hart Hall (E-5)
50 Nagle Hall (E-5)
51 Rudder Tower (D-4)
52 Bizzell Hall (E-4)
53 Goodwin Hall (E-4)
54 Coke Building (E-4)
55 G. Rollie White **Coliseum** (C-4)
56 Memorial Student Center (D-4)
57 Cain Athletic Hall (D-4)
58 Kleberg **Animal and Food Sciences** Center (D-3)
59 Heep Center for **Soil and Crop Sciences-Entomology** (D-3)
60 Veterinary Medicine Complex (E-2)
61 Biochemistry/Biophysics Building (D-3) (under construction)
62 Rosenthal **Meat Science and Technology** Center (C-3)
63 Horticulture Greenhouses (D-3)
64 Horticulture/Forest Science Building (C-2)
65 Adriance Lab (C-2)
66 Reynolds Medical Sciences Building (D-2)
67 Cater-Mattil Hall (E-3) (Food Protein R&D Center)
68 Medical Sciences Library (E-2)
69 Vivarium (F-2)
70 Laboratory Animal Resources Building (F-2)
71 Foundation Seed Service (F-2)
72 Texas Veterinary Medical Diagnostic Lab (F-2)
73 Agronomy Field Lab (G-2)
74 Entomology Research Lab (F-3)
75 Forest Science Lab (G-3)
76 Purchasing and Stores (G-2)
77 Agricultural Engineering Shops (E-3)
78 Bell Building (formerly USDA) (F-3)
79 Davis-Gary Hall (F-3)
80 Fowler Hall (F-4)
81 Keathley Hall (F-4)
82 Moses Hall (F-4)
83 Moore Hall (F-4)
84 Crocker Hall (G-3)
85 Henderson Hall (F-4)
86 Hughes Hall (F-4)
87 McInnis Hall (G-4)
88 Law Hall (E-4)
89 Puryear Hall (F-4)
90 All Faiths **Chapel** (F-4)
91 Special Services Building (F-4)
92 Haas Hall (F-4)
93 McFadden Hall (F-4)
94 Walton Hall (G-4)
95 Schuhmacher Hall (G-4)
96 YMCA Building (F-4)
97 Beutel **Health** Center (F-4)
98 Biological Control Facility (F-3)
99 Legett Hall (F-4)
100 Sbisa Dining Hall (G-4)
101 Hotard Hall (G-4)
102 Post Office (H-4)
103 Academic Building (F-5)
104 Bolton Hall (F-4)
105 Harrington **Education** Center-Office (F-4)
106 Fermier Hall (G-4) **(Engineering Technology)**
107 Admissions and Records (Heaton Hall) (G-4)
108 Construction Shop and Grounds Maintenance Building (G-4)
109 Biological Sciences Building (F-5)
110 Clements Hall (F-4)
111 Sterling C. Evans **Library** (F-5)
112 Harrington **Education** Center-Classroom (F-5)
113 Thompson Hall (G-5)
114 English Annex (G-4)
115 Milner Hall (G-4)
116 Utilities Plant (G-4)
117 Peterson Building (F-5) **(Plant Sciences** Building)
118 Francis Hall (G-5)
119 Chemistry Building (G-5)
120 Reed McDonald Building (H-5)
121 Forestry Greenhouses (F-6)
122 Dairy Science Building (F-6)
123 Dormitory (F-4) (under construction)
124 Pavilion, The (F-5)
125 Agriculture Building (G-5)
126 Engineering Building (G-5)
127 TAES Annex (F-6)
128 Computing Services Center (F-6)
129 Teague Research Center (F-6)
130 Animal Industries (F-6)
131 Oceanography and Meteorology Building (G-6)
132 Scoates Hall (G-5)
133 System Administration Building (G-6)
134 Golf Clubhouse (F-7)
135 Wisenbaker **Engineering Research** Center (I-5)
136 Golf Course Maintenance Building (D-7)
137 Engineering Building (CE/TTI) (I-5)
138 Langford **Architecture** Center (H-6)
139 Civil Engineering Building (H-5)
140 Concrete Materials Lab (I-5)
141 McNew **Engineering Lab** (I-5)
142 Hydromechanics Lab (I-5)
143 Zachry **Engineering** Center (I-5)
144 Richardson **Petroleum Engineering** Building (H-5) (under construction)
145 Aerospace Engineering/Computer Science Building (H-5) (under construction)
146 Doherty Building (H-5)
147 Cyclotron (I-5)
148 Halbouty **Geosciences** Building (H-5)
149 Printing Center (H-5)
150 Engineering/Physics Building (H-5)
151 Parking Garage (H-4) (under construction)
152 University Mail Service (H-4)
153 Facilities Building (H-4)
154 Transportation Center (H-2)
155 Blocker Building (H-5)
156 Hobby Hall (G-4)
157 Neeley Hall (G-4)
158 Transportation Annex (H-2)
159 Physical Plant/Grounds Maintenance Facility (H-2)
160 Food Services Commissary (I-2)
161 Physical Plant Offices and Shops (I-2)
200 Ocean Drilling Program Building (A-1)
201 One Research Park (B-1)
202 FSIS National Training Center (C-1) (under construction)

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