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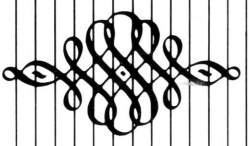

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UNIVERSITY

1985-86 graduate catalog announcements

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TEXAS A&M UNIVERSITY
1985-86 ACADEMIC CALENDAR

Summer Session 1985

June 3	Monday. Registration for first term and the 11-week semester.
June 4	Tuesday. First day of first term and 11-week semester classes.
June 6	Thursday. Last day for enrolling in the University for the first term and the 11-week semester and for adding new courses.
June 7	Friday. Last day for dropping courses with no record for the first term and the 11-week semester.
June 14	Friday. Last day for dropping courses with no penalty for the first term (Q-drop). Last day to apply for all degrees to be awarded in August for students completing degree requirements first term.
June 27	Thursday. Last day for dropping courses with no penalty for the 11-week semester (Q-drop).
July 4	Thursday. Independence Day holiday.
July 9	Tuesday. Last day of first term classes. Beginning of first term final examinations, 7 p.m.
July 10	Wednesday. Last day of first term final examinations.
July 11	Thursday. Registration for the second term.
July 12	Friday. First day of second term classes. First term final grades due in Registrar's Office, 10 a.m.
July 16	Tuesday. Last day for enrolling in the University for the second term and for adding new courses.
July 17	Wednesday. Last day for dropping courses with no record for the second term.
July 19	Friday. Last day to apply for all degrees to be awarded in August for students completing degree requirements the second term or 11-week semester.
July 24	Wednesday. Last day for dropping courses with no penalty for the second term (Q-drop).
August 13	Tuesday. Grades for graduating students due in Registrar's Office, 10 a.m.
August 14	Wednesday. Last day of 11-week semester classes. Beginning of 11-week semester final examinations, 7 p.m.
August 15	Thursday. Last day of second term classes. Beginning of second term final examinations, 7 p.m. Continuation of 11-week semester final examinations, 7 p.m.
August 16	Friday. Last day of second term and 11-week semester final examinations.
August 17	Saturday. Commencement for first and second term and 11-week semester graduating students.
August 19	Monday. Second term and 11-week semester final grades due in Registrar's Office, 10 a.m.

REGULAR SESSION

Fall Semester 1985

August 26-30	Monday-Friday. Delayed registration by classification.
August 27-30	Tuesday-Friday. Delayed drop/add by classification.
September 2	Monday. First day of fall semester classes.
September 2-6	Monday-Friday. Late registration and drop/add for all students.
September 6	Friday. Last day for enrolling in the University for the fall semester and for adding new courses.
September 13	Friday. Last day to apply for all degrees to be awarded in December.
September 17	Tuesday. Last day for dropping courses with no record.
October 4	Friday. Last day for dropping courses with no penalty (Q-drop).
October 21	Monday. Midsemester grades due in Registrar's Office, 10 a.m.
November 11-22	Monday-Friday. Preregistration for the 1986 spring semester.
November 28-29	Thursday-Friday. Thanksgiving holiday.
December 6	Friday. Grades for graduating students due in Registrar's Office, 4 p.m.
December 13	Friday. Last day of fall semester classes. Last day to withdraw officially from the University. Commmencement.
December 14	Saturday. Commencement.
December 16-20	Monday-Friday. Fall semester final examinations.
December 21	Saturday. Final grades due in Registrar's Office, 12 noon.

Spring Semester 1986

January 6-10	Monday-Friday. Open registration and drop/add for all students.
January 13-17	Monday-Friday. Delayed registration by classification.
January 14-17	Tuesday-Friday. Delayed drop/add by classification.
January 20	Monday. First day of spring semester classes.
January 20-24	Monday-Friday. Late registation and drop/add for all students.
January 24	Friday. Last day for enrolling in the University for the spring semester and for adding new courses.
February 4	Tuesday. Last day for dropping courses with no record.
February 7	Friday. Last day to apply for all degrees to be awarded in May.
February 21	Friday. Last day for dropping courses with no penalty (Q-drop).
March 10	Monday. Midsemester grades due in Registrar's Office, 10 a.m.
March 17-21	Monday-Friday. Spring break.
April 14-25	Monday-Friday. Preregistration for the 1986 fall semester.
May 2	Friday. Grades for graduating students due in Registrar's Office, 4 p.m.
May 9	Friday. Last day of spring semester classes. Last day to withdraw officially from the University. Commencement.
May 10	Saturday. Commencement and Final Review.
May 12-16	Monday-Friday. Spring semester final examinations.
May 19	Monday. Final grades due in Registrar's Office, 10 a.m.

Summer Session 1986

June 2	Monday. Registration for first term and the 11-week semester.
June 3	Tuesday. First day of first term and 11-week semester classes.
June 5	Thursday. Last day for enrolling in the University for the first term and the 11-week semester and for adding new courses.
June 6	Friday. Last day for dropping courses with no record for the first term and the 11-week semester.
June 13	Friday. Last day for dropping courses with no penalty for the first term (Q-drop). Last day to apply for all degrees to be awarded in August for students completing degree requirements first term.
June 26	Thursday. Last day for dropping courses with no penalty for the 11-week semester (Q-drop).
July 4	Friday. Independence Day holiday.
July 8	Tuesday. Last day of the first term classes. Beginning of first term final examinations, 7 p.m.
July 9	Wednesday. Last day of first term final examinations.
July 10	Thursday. Registration for the second term.
July 11	Friday. First day of second term classes. First term final grades due in Registrar's Office, 10 a.m.
July 15	Tuesday. Last day for enrolling in the University for the second term and for adding new courses.
July 16	Wednesday. Last day for dropping courses with no record for the second term.
July 18	Friday. Last day to apply for all degrees to be awarded in August for students completing degree requirements the second term or 11-week semester.
July 23	Wednesday. Last day for dropping courses with no penalty for the second term (Q-drop).
August 12	Tuesday. Grades for graduating students due in Registrar's Office, 10 a.m.
August 13	Wednesday. Last day of 11-week semester classes. Beginning of 11-week semester examinations, 7 p.m.
August 14	Thursday. Last day of second term classes. Beginning of second term final examinations, 7 p.m. Continuation of 11-week semester final examinations, 7 p.m.
August 15	Friday. Last day of second term and 11-week semester final examinations.
August 16	Saturday. Commencement for first and second term and 11-week semester graduating students.
August 18	Monday. Second term and 11-week semester final grades due in Registrar's Office, 10 a.m.

GRADUATE FACULTY

(Listings of degrees and rank correct as of October 1, 1984. Listings of Graduate Faculty membership correct as of January 15, 1985. Figures in parentheses indicate date of first appointment on the University staff and date of appointment to present position, respectively.)

Abelson, Michael A., *Assistant Professor of Management.* (1980) 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.

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., *Assistant Professor of Wildlife and Fisheries Sciences.* (1981) 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.

Adams, Ralph James Q., *Associate Professor of History.* (1974, 1979) B.S., Indiana University, 1965; M.A., Valparaiso University, 1969; Ph.D., University of California, Santa Barbara, 1972.

Adkisson, Perry Lee, *Deputy Chancellor, The Texas A&M University System, and Distinguished Professor of Entomology.* (1958, 1983) B.S., University of Arkansas, 1950; M.S., 1954; Ph.D., Kansas State University, 1956.

Aguirre, Benigno E., *Associate Professor of Sociology.* (1977, 1983) B.A., Florida State University, 1970; M.A., Tulane University, 1971; Ph.D., Ohio State University, 1977.

Ahr, Wayne Merrill, *Professor of Geology.* (1970, 1983) B.S., University of Texas at El Paso, 1960; M.S., Texas A&M University, 1965; Ph.D., Rice University, 1967.

Akgerman, Aydin, *Associate Professor, Chemical Engineering.* (1980, 1981) B.S., Robert College, 1968; M.S., University of Virginia, 1969; Ph.D., 1971.

Albanese, Robert, *Professor of Management.* (1971, 1976) B.S., Ohio State University, 1952; M.B.A., 1957; Ph.D., 1962.

Albrecht, Don E., *Research Scientist, Department of Recreation and Parks.* (1981) B.S., Utah State University, 1976; M.S., 1978; Ph.D., Iowa State University, 1981.

Aldred, William Hughes, P.E., *Associate Professor of Agricultural Engineering.* (1953, 1976) B.S., University of Georgia, 1951; M.S., Texas A&M University, 1956.

Aldrich, David Virgil, *Professor of Marine Biology (Galveston), Department of Wildlife and Fisheries Sciences.* (1966, 1979) A.B., Kenyon College, 1950; M.A., Rice University, 1952; Ph.D., 1954.

Alexander, Patricia Ann, *Assistant Professor of Educational Curriculum and Instruction.* (1981) B.A., Bethel College, 1970; M.Ed., James Madison University, 1979; Ph.D., University of Maryland, 1981.

Alexander, Richard M., P.E., *Associate Professor of Mechanical Engineering.* (1977, 1981) B.S., Texas A&M University, 1965; M.S., 1967; Ph.D., University of Texas at Arlington, 1975.

Alexander, Steve K., *Assistant Professor of Marine Biology (Galveston), Department of Biology.* (1978) B.S., University of Houston, 1972; M.S., Louisiana State University, 1973; Ph.D., 1976.

Allen, David H., P.E., *Assistant Professor of Aerospace Engineering.* (1981) B.S., Texas A&M University, 1972; M.Eng., 1977; Ph.D., 1980.

Allen, Graham Donald, *Associate Professor of Mathematics.* (1971, 1976). B.S., University of Wisconsin, 1965; M.S., 1966; Ph.D., 1971.

Allen, John William, *Professor of Economics.* (1967, 1978) B.S., University of Illinois, 1958; M.S., 1963; Ph.D., 1967.

Allen, Phillip E., P.E., *Professor of Electrical Engineering.* (1976, 1984) B.S., California State University, 1962; M.S., 1965; Ph.D., University of Kansas, 1970.

Allen, Roland E., *Professor of Physics.* (1970, 1983) B.A., Rice University, 1963; B.A., University of Houston, 1965; Ph.D., University of Texas at Austin, 1969.

Alston, Jon P., *Professor of Sociology.* (1974, 1980) B.A., Emory University, 1960; M.S., Florida State University, 1962; Ph.D., University of Texas at Austin, 1971.

Amoss, Max St. Clair, Jr., *Associate Professor of Veterinary Physiology and Pharmacology.* (1975, 1980) B.S., Pennsylvania State University, 1962; M.S., Texas A&M University, 1965; Ph.D., Baylor College of Medicine, 1969.

Anderson, Carol Riggs, *Professor of Educational Psychology.* (1969, 1980) B.S., Texas Woman's University, 1958; M.A., 1962; Ed.D., Columbia University, 1966.

Anderson, David R., *Assistant Professor of English.* (1981) B.A., Saint Olaf College, 1974; Ph.D., Boston College, 1978.

Anderson, Duwayne M., *Associate Provost for Research and Professor of Geology.* (1984) B.Sc., Brigham Young University, 1954; Ph.D., Purdue University, 1958.

Anderson, Gary C., *Assistant Professor of History.* (1981) B.A., Concordia College, 1971; M.A., University of South Dakota, 1972; Ph.D., University of Toledo, 1978.

Anderson, James Gilbert, Jr., *Professor of Veterinary Physiology and Pharmacology.* (1966, 1976) B.S., Texas A&M University, 1952; D.V.M., 1966; M.S., 1970.

Anderson, Richard Kenneth, *Associate Professor of Economics.* (1975, 1980) B.A., Rockford College, 1967; M.A.T., 1971; M.S., Purdue University, 1972; Ph.D., 1975.

Anderson, Terry H., *Associate Professor of History.* (1979, 1984) B.A., University of Minnesota, 1971; M.A., University of Missouri, 1973; Ph.D., Indiana University, 1978.

Anderson, Warren Boyd, *Associate Professor of Agronomy.* (1964, 1971) B.S., Brigham Young University, 1958; M.S., Colorado State University, 1962; Ph.D., 1964.

Andreadis, Harriette, *Assistant Professor of English.* (1975) B.A., Temple University, 1961; M.A., 1966; Ph.D., University of Wisconsin, 1970.

Andrews, Kevin T., *Assistant Professor of Mathematics.* (1980) B.S., University of Michigan, 1974; M.S., University of Illinois, 1975; Ph.D., 1980.

Anjaneyulu, Yellapu, *Assistant Professor, Electrical Engineering.* (1980, 1981) B.S., Mysore University, 1963; M.S., Bangalore University, 1969; Ph.D., Ohio University, 1977.

Annamalai, K., P.E., *Assistant Professor of Mechanical Engineering.* (1981) B.S., University of Madras (India), 1966; M.S., Indian Institute of Science, 1968; Ph.D., Georgia Institute of Technology, 1975.

Anthony, Rayford Gaines, P.E., *Professor of Chemical Engineering.* (1966, 1974) B.S., Texas A&M University, 1958; M.S., 1962; Ph.D., University of Texas at Austin, 1966.

Anthony, Ted F., *Associate Professor of Business Analysis and Research.* (1976) B.B.A., North Texas State University, 1960; M.B.A., Texas A&M University, 1965; D.B.A., University of Colorado, 1971.

Apostolou, Nicholas G., *Assistant Professor of Accounting.* (1982) B.A., Union College, 1964; M.B.A., University of California, Los Angeles, 1966; D.B.A., University of Tennessee, 1982.

Appel, David Nye, *Assistant Professor of Plant Pathology.* (1981) B.A, West Virginia University, 1973; M.S., 1976; Ph.D., Virginia Polytechnic Institute and State University, 1980.

Appleberry, Mary Hilton, *Visiting Member, Department of Educational Curriculum and Instruction.* (1974) B.A., Pepperdine College, 1942; M.Ed., University of Houston, 1960; Ed.D., 1969.

Archer, Stanley Louis, *Professor of English.* (1962, 1970) B.S., Texas A&M University, 1959; M.A., University of Mississippi, 1961; Ph.D., 1965.

Archer, Steven R., *Assistant Professor of Range Science and of Plant Physiology.* (1983) B.A., Augustana College, 1975; M.S., Colorado State University, 1980; Ph.D., 1983.

Archer, Thomas L., *Associate Professor of Entomology, TAMU Agricultural Research and Extension Center (Lubbock).* (1977) B.S., California State Polytechnic College, Pomona, 1966; Ph.D., University of California, Riverside, 1971.

Arkin, Gerald F., *Associate Professor of Agricultural Engineering, Blackland Research Center (Temple).* (1976) B.S., Cornell University, 1966; M.S., University of Georgia, 1968; Ph.D., University of Illinois, 1971.

Armstrong, David Grant, *Professor of Educational Curriculum and Instruction.* (1975, 1984) B.A., Stanford University, 1962; M.A., University of Montana, 1967; Ph.D., University of Washington, 1973.

Arnold, Keith Alan, *Professor of Wildlife and Fisheries Sciences.* (1966, 1978) A.B., Kalamazoo College, 1959; M.S., University of Michigan, 1961; Ph.D., Louisiana State University, 1966.

Ash, Michael James, *Professor of Educational Psychology and Head of Department.* (1973, 1983) B.A., Arizona State University, 1969; M.A., 1973; Ph.D., 1974.

Ashcraft, Allan Coleman, *Professor of History.* (1956, 1975) B.A., Texas A&M University, 1950; M.A., Columbia University, 1951; Ph.D., 1960.

Ashworth-Tsutsui, Ethel, *Associate Professor of Biochemistry and Biophysics.* (1968) A.B., Keuka College, 1948; Ph.D., University of Rochester, 1954.

Auer, Joerg A., *Associate Professor of Veterinary Large Animal Medicine and Surgery.* (1978, 1983) D.V.M., University of Zurich, 1974; M.S., Texas A&M University, 1981; Diplomate, American College of Veterinary Surgeons, 1982.

Auernheimer, Leonardo, *Associate Professor of Economics.* (1973, 1978) Lic. Econ., University of Buenos Aires, 1966; M.A., University of Chicago, 1970; Ph.D., 1973.

Aufderheide, Karl John, *Assistant Professor of Biology and of Genetics.* (1979) B.S., University of Minnesota, 1970; M.S., 1972; Ph.D., 1974.

Austin, Donald B., *Professor of Landscape Architecture.* (1974, 1977) B.S., Texas A&M University, 1953; M.A., University of Oregon, 1958; Registered Landscape Architect, A.S.L.A.

Austin, John C., *Visiting Member, Department of Educational Curriculum and Instruction.* (1974) B.S., Sam Houston State University, 1950; M.Ed., Stephen F. Austin State University, 1952; Ed.D., University of Houston, 1967.

Ayoub, Abdel-Kader, P.E., *Professor of Electrical Engineering.* (1968, 1978) B.S., University of Alexandria (United Arab Republic), 1948; M.S., University of Texas at Austin, 1952; Ph.D., 1955.

Bailey, Christopher A., *Assistant Professor of Poultry Science and of Nutrition.* (1983) B.S., Texas A&M University, 1977; M.S., 1979; Ph.D., 1982.

Bailey, E. Murl, Jr., *Professor of Veterinary Physiology and Pharmacology.* (1970, 1981) D.V.M., Texas A&M University, 1964; M.S., Iowa State University, 1966; Ph.D., 1968; Diplomate, American Board of Veterinary Toxicology, 1972.

Bailey, Guy H., *Assistant Professor of English.* (1982) B.A., University of Alabama, 1972; M.A., 1974; Ph.D., University of Tennessee, 1979.

Bakelman, Ilya, *Professor of Mathematics.* (1981, 1982) B.A., University of Leningrad, 1951; Ph.D., 1954.

Baker, Glenn E., *Professor of Industrial, Vocational and Technical Education.* (1977, 1982) B.S., Texas A&M University, 1956; M.Ed., 1961; Ed.D., 1966.

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Vinson, S. Bradleigh, *Professor of Entomology.* (1969, 1975) B.S., Ohio State University, 1961; M.S., Mississippi State University, 1963; Ph.D., 1965.

Von Gonten, William D., P.E., *Professor of Petroleum Engineering and Head of Department.* (1966, 1976) B.S., Texas A&M University, 1957; M.S., 1965; Ph.D., 1966.

von Lavante, Ernst, *Assistant Professor, Aerospace Engineering.* (1981) Dipl.Ing., University of Munich, 1976; M.S., University of Illinois, 1978; Ph.D., 1980.

Vrooman, Richard E., *Professor of Environmental Design and of Architecture.* (1949, 1960) A.B., Oberlin College, 1941; B.Arch., Case Western Reserve University, 1949; M.Arch., Texas A&M University,1952; Registered Architect; F.A.I.A.

Vulliet, Philip R., *Assistant Professor of Veterniary Physiology and Pharmacology.* (1981) B.S., University of California, Irvine, 1972; Ph.D., University of Colorado Health Science Center, 1980; D.V.M., Colorado State University, 1981.

Wade, Dale A., *Extension Specialist, Department of Wildlife and Fisheries Sciences.* (1982) B.S., South Dakota State University, 1969; Ph.D., 1972.

Wagner, Gerald G., *Associate Professor of Veterinary Microbiology and Parasitology.* (1977) B.S., Texas Tech University, 1963; M.S., University of Kansas, 1966; Ph.D., 1968.

Wagner, Jackson Wayne, *Professor of Anatomy and Head of Department.* (1974, 1978) A.B., Fresno State College, 1957; Ph.D., University of California, San Francisco, 1960; M.D., Baylor College of Medicine, 1973.

Walker, James Knox, Jr., *Professor of Entomology.* (1968, 1981) B.S., Texas A&M University, 1951; M.S., 1956.

Walton, Jay Robert, *Associate Professor of Mathematics.* (1973, 1979) B.A., DePauw University, 1968; M.A., Indiana University, 1970; Ph.D., 1973.

Want, E. Cleve, *Associate Professor of English.* (1966, 1974) B.A., Hendrix College, 1956; M.A., George Peabody College, 1957; B.D., Episcopal Theological Seminary of the Southwest, 1966; Ph.D., Vanderbilt University, 1968.

Ward, Donald T., *Associate Professor, Aerospace Engineering.* (1981) B.S., University of Texas at Austin, 1958; M.S., Air Force Institute of Technology, 1965; Ph.D., Mississippi State University, 1974.

Ward, Joseph D., *Associate Professor of Mathematics.* (1974, 1980) B.S., Boston College, 1968; M.S., Purdue University, 1970; Ph.D., 1973.

Ward, Thomas B., *Assistant Professor of Psychology.* (1981) B.S., Rider College, 1974; M.S., University of Wisconsin, 1975; Ph.D., 1978.

Watson, Albert Theodore, Jr., P.E., *Assistant Professor of Chemical Engineering.* (1978) B.S., University of Texas at Austin, 1974; Ph.D., California Institute of Technology, 1978.

Watson, Rand Lewis, *Assistant Dean, College of Science, and Professor of Chemistry.* (1967, 1980) B.S., Colorado School of Mines, 1962; Ph.D., University of California, Berkeley, 1966.

Weaver, Dave, *Extension Specialist, Department of Soil and Crop Sciences.* (1977) B.S., Texas Tech University, 1961; M.S., 1963; Ph.D., 1970.

Weaver, Richard W., *Professor of Agronomy.* (1970, 1982) B.S., Utah State University, 1966; Ph.D., Iowa State University, 1970.

Webb, Bill Dean, *USDA Scientist, TAMU Agricultural Research and Extension Center (Beaumont), Department of Soil and Crop Sciences.* (1963) B.S., Texas A&M University, 1956; M.S., 1959; Ph.D., 1961.

Webb, James W., *Assistant Professor of Marine Biology (Galveston), Department of Range Science.* (1982) B.S., University of South Carolina, 1966; M.S., University of Georgia, 1971; Ph.D., Texas A&M University, 1977.

Webb, Robert C., Sr., *Associate Professor of Physics.* (1980) B.A., University of Pennsylvania, 1968; M.A., Princeton University, 1970; Ph.D., 1972.

Wehrly, Thomas E., *Associate Professor of Statistics.* (1976, 1982) B.S., University of Michigan, 1969; M.A., University of Wisconsin, 1970; Ph.D., 1976.

Weir, Glendon H., *Associate Professor of Anthropology.* (1976, 1982) B.A., Texas A&M University, 1974; Ph.D., 1976.

Weitsman, Yechiel, P.E., *Professor of Civil Engineering.* (1977) B.S., Technion-Israel Institute of Technology, 1953; M.S., University of Connecticut, 1959; Ph.D., Rensselaer Polytechnic Institute, 1962.

Welch, Tommy G., *Extension Specialist, Department of Range Science.* (1972, 1982) B.S., Texas Tech University, 1965; M.S., Colorado State University, 1967; Ph.D., University of Arizona, 1973.

Weller, Milton W., *Professor of Wildlife and Fisheries Sciences and Holder of the Caesar Kleberg Chair in Wildlife Ecology.* (1982) A.B., University of Missouri, 1951; M.A., 1954; Ph.D., 1956.

Wellman, Paul J., *Assistant Professor of Psychology.* (1980) B.A., California State College-Bakersfield, 1975; M.S., Iowa State University, 1977; Ph.D., 1980.

Wells, Ward V., *Associate Professor of Architecture.* (1977, 1980) B.Arch., Kansas State University, 1973; M.Arch., University of Oklahoma, 1976; Associate Member, A.I.A.

Welsh, Thomas Howard, Jr., *Assistant Professor of Animal Science.* (1983) B.S., North Carolina State University, 1974; Ph.D., 1980.

Wendler, Walter V., *Associate Professor of Environmental Design and of Architecture.* (1981, 1983) B.E.D., Texas A&M University, 1972; M.Arch., University of California, 1975; Registered Architect.

Wendt, Charles W., *Professor of Soil Science, TAMU Agricultural Research and Extension Center (Lubbock).* (1966, 1975) B.S., Texas A&M University, 1951; M.S., Texas Tech University, 1957; Ph.D., Texas A&M University, 1966.

West, Philip T., *Professor of Educational Administration.* (1974, 1981) B.S., Boston University, 1962; M.S., Hofstra University, 1967; Ph.D., University of Iowa, 1971.

West, William F., *Assistant Professor of Political Science.* (1981) B.S., U.S. Military Academy, 1971; M.A., Rice University, 1979; Ph.D., 1981.

Westphal, Joanne, *Assistant Professor of Recreation and Parks.* (1979) B.S., Wisconsin State University, 1970; M.S., University of Wisconsin-Madison, 1973; Ph.D., 1977; M.A., 1982.

Wharton, Robert Alan, *Assistant Professor of Entomology.* (1982) B.S., California State Polytechnic University, 1969; M.S., University of Connecticut, 1971; Ph.D., University of California, Berkeley, 1976.

White, Edna M., *Assistant Professor of Business Analysis and Research.* (1983) B.A., Stanford University, 1966; Ph.D., University of Minnesota, 1983.

White, Kenneth L., *Associate Professor of Geography.* (1976, 1982) B.A., California State University, 1969; M.A., 1970; Ph.D., University of California, 1976.

White, Larry D., *Extension Specialist, Department of Range Science.* (1981) B.S.F., Northern Arizona State University, 1963; M.S., University of Arizona, 1965; Ph.D., 1967.

White, Ralph E., P.E., *Associate Professor of Chemical Engineering.* (1977, 1981) B.S., University of South Carolina, 1971; M.S., University of California, Berkeley, 1973; Ph.D., 1977.

Whiting, Robert Louis, P.E., *Professor of Petroleum Engineering.* (1946, 1949) B.S., University of Texas at Austin, 1939; M.S., 1943.

Whitney, N. G., *Associate Professor of Plant Pathology, TAMU Agricultural Research and Extension Center (Beaumont).* (1976, 1979) B.S., University of Houston, 1964; M.A., Sam Houston State University, 1967; Ph.D., Texas A&M University, 1972.

Whittington, David L., *Visiting Member, Department of Range Science.* (1983) B.S., University of Missouri, 1972; M.S., 1973; Ph.D., Oregon State University, 1978.

Wick, Robert Senters, P.E., *Professor of Nuclear Engineering.* (1966) B.S., Rensselaer Polytechnic Institute, 1946; M.S., Stevens Institute of Technology, 1948; Ph.D., University of Illinois, 1952.

Wichern, Dean W., *Professor of Business Analysis and Research and Head of Department.* (1984) B.S., University of Wisconsin, 1964; M.S., 1965; Ph.D., 1969.

Wicksten, Mary Katherine, *Assistant Professor of Biology.* (1980, 1983) B.A., Humboldt State College, 1970; M.A., 1972; Ph.D., University of Southern California, 1977.

Wiedenfeld, Robert P., *Assistant Professor of Soil and Crop Sciences, TAES (Weslaco).* (1972) B.S., California State University, Humboldt, 1972; M.S., Texas A&M University, 1974; Ph.D., 1978.

Wiersig, Donald Otto, *Professor of Veterinary Physiology and Pharmacology.* (1967, 1973) D.V.M., Iowa State University, 1949; Ph.D., 1967; Diplomate, American Board of Veterinary Toxicology, 1980.

Wiese, Allen Franklin, *Professor of Agronomy, TAMU Agricultural Research and Extension Center (Amarillo).* (1966, 1967) B.S., University of Minnesota, 1949; M.S., 1951; Ph.D., 1953.

Wiggins, Casper E., Jr., *Assistant Professor of Accounting.* (1982) B.A., Wofford College, 1971; M.B.A., University of Georgia, 1974; M.S., Clemson University, 1978; D.B.A., University of Tennessee, 1982.

Wiggins, Charles W., *Professor of Political Science and Interim Head of Department.* (1981, 1984) B.A., State University of Iowa, 1959; M.A., Washington University, 1963; Ph.D., 1964.

Wiggins, Steven N., *Associate Professor of Economics.* (1979, 1984) B.A., Oklahoma State University, 1975; Ph.D., Massachusetts Institute of Technology, 1979.

Wild, James Robert, *Professor of Biochemistry and Biophysics and of Genetics.* (1975, 1984) B.A., University of California, Davis, 1967; Ph.D., University of California, Riverside, 1971.

Wilding, Lawrence P., *Professor of Agronomy.* (1976) B.S., South Dakota State University, 1956; M.S., 1959; Ph.D., University of Illinois, 1962.

Wilhoit, Randolph C., *Associate Professor of Chemistry.* (1964) B.A., Trinity University, 1947; M.A., University of Kansas, 1949; Ph.D., Northwestern University, 1952.

Wilkes, Lambert Henry, P.E., *Professor of Agricultural Engineering.* (1948, 1975) B.S., Clemson University, 1948; M.S., Texas A&M University, 1953.

Willemann, Raymond J., *Assistant Professor of Geophysics.* (1982) B.S., University of Rochester, 1978; Ph.D., Cornell University, 1982.

Williams, Dana Peter, *Assistant Professor of Mathematics.* (1979, 1980) B.A., Cornell University, 1974; M.A., University of California, Berkeley, 1977; Ph.D., 1979.

Williams, Gary L., *Associate Professor of Animal Science.* (1984) B.S., New Mexico State University, 1972; M.S., 1974; Ph.D., University of Arizona, 1978.

Williams, Glen Nordyke, P.E., *Associate Professor of Computer Science.* (1969, 1975) B.S., Texas A&M University, 1960; M.Eng., 1961; Ph.D., 1965.

Williams, John Donald, *Associate Professor of Veterinary Microbiology and Parasitology.* (1974) B.S., Texas A&M University, 1955; M.S., 1957; Ph.D., 1961.

Willson, Victor L., *Associate Professor of Educational Psychology.* (1979) B.A., University of Colorado, 1968; Ph.D., 1973.

Wilson, Hugh D., *Associate Professor of Biology and of Genetics.* (1977, 1983) B.A., Kent State University, 1970; M.A., 1972; Ph.D., Indiana University, 1976.

Wilson, Van Gene, *Assistant Professor of Medical Microbiology and Immunology.* (1983) B.S., Georgia Institute of Technology, 1975; Ph.D., Case Western Reserve University, 1980.

Wiseman, Donna Louise, *Associate Professor of Educational Curriculum and Instruction.* (1979, 1984) B.S., Oklahoma State University, 1968; M.S., Arkansas State University, 1976; Ph.D., University of Missouri, 1979.

Witz, John A., *Research Scientist, Department of Agricultural Engineering.* (1973) B.S., North Dakota State University, 1966; Ph.D., Oklahoma State University, 1972.

Witzel, Donald A., *USDA Scientist, Department of Veterinary Physiology and Pharmacology.* (1974, 1983) B.S., University of Minnesota, 1953; D.V.M., 1957; M.S., Iowa State University, 1965; Ph.D., 1970.

Wolf, Kevin L., *Professor of Chemistry.* (1982) B.S., Purdue University, 1964; Ph.D., University of Washington, 1969.

Wolfenden, Alan, *Professor, Mechanical Engineering.* (1982, 1984) B.Sc., University of Liverpool (England), 1961; Ph.D., 1965.

Wohlgenant, Michael K., *Associate Professor of Agricultural Economics.* (1983) B.S., Montana State University, 1972; M.S., 1973; Ph.D., University of California, Davis, 1977.

Womack, James E., *Professor of Veterinary Pathology and of Genetics.* (1977, 1983) B.S., Abilene Christian University, 1964; Ph.D., Oregon State University, 1968.

Wong, Chi-Huey, *Assistant Professor of Chemistry.* (1983) B.S., National Taiwan University, 1970; M.S., 1977; Ph.D., Massachusetts Institute of Technology, 1982.

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, *Assistant Professor of Psychology.* (1982) B.S., University of Illinois, 1975; M.S., University of Massachusetts, 1978; Ph.D., 1980.

Woodcock, David Geoffrey, *Professor of Architecture and Head of Department.* (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.

Woodman, Richard W., *Associate Professor of Management.* (1978, 1982) B.S., Oklahoma State University, 1968; M.B.A., 1969; Ph.D., Purdue University, 1978.

Woods, Calvin E., P.E., *Professor 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 L., P.E., *Professor of Civil Engineering.* (1963, 1973) B.S., Oklahoma State University, 1955; M.S., 1960; Ph.D., Texas A&M University, 1967.

Woods, Michael Denton, *Extension Specialist, Department of Agricultural Economics.* (1981) B.S., Arkansas Tech University, 1975; M.S., University of Arkansas, 1978; Ph.D., Oklahoma State University, 1981.

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, Stephen, *Professor of Psychology and Head of Department.* (1983) B.A., University of Texas at Austin, 1967; Ph.D., Duke University, 1971.

Wormuth, John Hazen, *Associate Professor of Oceanography.* (1972, 1977) B.A., Hope College, 1966; Ph.D., Scripps Institution of Oceanography, 1971.

Wright, Arthur L., *Associate Professor of Agricultural Economics.* (1972) B.S., Southern Illinois University, 1960; M.S., 1961; Ph.D., University of Missouri, 1970.

Wu, Albert Ming-Tao, *Associate Professor of Veterinary Pathology.* (1982) B.S., National Taiwan University, 1965; Ph.D., New York Medical College, 1975.

Wu, Ching H., P.E., *Professor 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, *Associate Professor, Bioengineering.* (1977, 1981) B.S., Tunghai University (Taiwan), 1960; M.S., University of Missouri, 1964; Ph.D., 1967.

Wurbs, Ralph A., P.E., *Assistant Professor of Civil Engineering.* (1980, 1981) B.S., Texas A&M University, 1971; M.S., University of Texas at Arlington, 1974; Ph.D., Colorado State University, 1978.

Wylie, Wayne E., *Assistant Professor of Health and Physical Education.* (1981) 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.

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., *Associate Professor of Chemistry.* (1978, 1983) 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, 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, Robert E., *Associate Professor, Industrial Engineering.* (1979, 1983) B.S.E., University of California, 1970; M.S.I.E., Purdue University, 1972; Ph.D., 1977.

Young, Ryland F., *Associate Professor of Medical Biochemistry.* (1978, 1983) B.S., 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.

Yuen, T. Steven, *Assistant Professor of Meteorology.* (1983) B.Sc., Chinese University of Hong Kong, 1974; M.Sc., University of Washington, 1977; Ph.D., 1979.

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.

Zeithaml, Carl P., *Assistant Professor of Management.* (1980) A.B., University of Notre Dame, 1971; M.B.A., University of Florida, 1974; D.B.A., University of Maryland, 1980.

Zeithaml, Valarie A., *Assistant Professor of Marketing.* (1980) B.A., Gettysburg College, 1970; M.B.A., University of Maryland, 1977; D.B.A., 1980.

Zey-Ferrell, Mary, *Professor of Sociology.* (1982) B.S., Louisiana Polytechnic Institute, 1964; M.S., Florida State University, 1965; Ph.D., Louisiana State University, 1972.

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, *Lecturer, Agricultural Engineering.* (1975) B.S., Texas A&M University, 1950; M.S., 1951.

Zinn, Joel, *Professor of Mathematics.* (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.

DISTINGUISHED PROFESSORS

Adkisson, Perry L., *Distinguished Professor of Entomology.*

Bass, George F., *Distinguished Professor of Anthropology.*

Bockris, John O'M., *Distinguished Professor of Chemistry.*

Borlaug, Norman E., *Distinguished Professor of International Agriculture.*

Calhoun, John C., Jr., *Distinguished Professor of Petroleum Engineering.*

Cotton, F. Albert, *Distinguished Professor of Chemistry and Holder of the W. T. Doherty-Welch Foundation Chair in Chemistry.*

Flipse, John E., *Distinguished Professor of Civil Engineering and of Ocean Engineering.*

Greenhut, M. L., *Distinguished Professor of Economics.*

Hall, Timothy C., *Distinguished Professor of Biology.*

Kettleborough, Charles F., *Distinguished Professor of Mechanical Engineering.*

Kilby, Jack S., *Distinguished Professor of Electrical Engineering.*

McDermott, John J., *Distinguished Professor of Philosophy and Humanities.*

Martell, Arthur E., *Distinguished Professor of Chemistry.*

Parzen, Emanuel, *Distinguished Professor of Statistics.*

Reid, Robert O., *Distinguished Professor of Oceanography.*

Richardson, Herbert H., *Distinguished Professor of Engineering.*

Safe, Stephen H., *Distinguished Professor of Veterinary Physiology and Pharmacology and Holder of the Chester J. Reed Chair of Veterinary Medicine.*

Schapery, Richard A., *Alumni Professor and Distinguished Professor of Aerospace Engineering and of Civil Engineering.*

Scott, A. Ian, *Distinguished Professor of Chemistry and Holder of the Davidson Chair in Science.*

Summers, Max D., *Distinguished Professor of Entomology.*

Texas A&M University

Texas A&M University, the state's first public institution of higher learning, was established in 1876 as a land-grant college. It grew rapidly as an all-male, all-military institution, teaching the agricultural and mechanical arts.

In keeping with the diversified and expanded character of the institution, the 58th Legislature of Texas, on August 23, 1963, changed the name of the Agricultural and Mechanical College of Texas to Texas A&M University. Women were admitted in 1963, and military training became voluntary in 1965.

Currently 36,846 students, including 6,162 in the Graduate College, are enrolled in the University. The University also supports the largest Corps of Cadets outside of the military academies with about 2,000 young men and women carrying on the traditions of the Corps.

Texas A&M is one of the fastest growing universities in the nation. Undergraduate degrees are offered in 93 areas of study, master's degrees in 144 and doctoral degrees in 93 areas. There are 84 departments in the colleges of Agriculture, Architecture and Environmental Design, Business Administration, Education, Engineering, Geosciences, Liberal Arts, Medicine, Science and Veterinary Medicine. Texas A&M is one of the few universities with a dual land-grant and sea-grant title. There are approximately 2,200 faculty members, 53 percent of whom are tenured. Construction to meet the needs of the student body has continued on the 5,142-acre campus.

The Sterling C. Evans Library has holdings of 1.4 million volumes. The Computing Services Center is equipped with an Amdahl 470 V/6-11 and an Amdahl 470 V/8. There are about 300 other computers, from micros through large scale, many of which, along with about 1,000 terminals of various types, access the main computer system via dial-up or dedicated communication lines.

Texas A&M is the state's leading university research center with a research investment in excess of $100 million a year. The University is among the top 20 in the nation for research and development expenditures for public institutions. Texas A&M also ranks among the top five public institutions in the nation which have the largest amounts of private financial support. In addition, the University is sixth in the nation in number of National Merit Scholars enrolled and is first among public institutions in attracting these outstanding students.

Millions of Texans benefit from The Texas A&M University System's statewide extension and experiment efforts including the programs of the Texas Agricultural Experiment Station, Texas Agricultural Extension Service, Texas Engineering Experiment Station, Texas Engineering Extension Service, Texas Forest Service, Texas Transportation Institute and Texas Veterinary Medical Diagnostic Laboratory.

Academic units of The Texas A&M University System include Texas A&M University, Texas A&M University at Galveston, Prairie View A&M University and Tarleton State University.

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.

TEXAS · A&M

THE GRADUATE COLLEGE

The principal objective of the Graduate College is to offer education beyond the baccalaureate level to those who aspire to become intellectual leaders in the professions and in various fields of teaching and research. It undertakes to assist graduate students in developing and pursuing individual educational programs requiring superior accomplishment through carefully directed intellectual activity.

GENERAL INFORMATION

Purpose. The purpose of this catalog is to provide information about the graduate programs of Texas A&M University to students and prospective students, as well as to the faculty and staff of the University. Included is information concerning requirements for admission to the Graduate College of Texas A&M University, services available to students, graduate course offerings and listings of the administrative officers and the graduate faculty of the University.

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

This catalog was prepared well in advance of its effective date; therefore the course descriptions may vary somewhat from actual course content due to advancements in the discipline, interests of individual professors, or decisions to change the scope of a course. Thus the descriptions 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, including any programs, et cetera.

The Graduate Faculty. The Graduate Faculty shall consist of the President, the Provost and Vice President for Academic Affairs, the Associate Provosts, the Dean of the Graduate College, the Deans of all subject-matter colleges, selected Directors, and a properly qualified academic group appointed by the Dean of the Graduate College.

The Dean of the Graduate College is responsible for the academic programs of all graduate students. He is the representative of the graduate faculty and is the medium of communication between the graduate students and the University administration.

The Graduate Council is a standing committee of the Faculty Senate. It is an advisory body to the Dean of the Graduate College, who is the chief administrative officer of the graduate faculty. There is a Committee on Graduate Instruction in each of the several colleges. These committees are responsible for making recommendations for graduate work in the college concerned, for making recommendations regarding general policies, and for other matters pertaining to graduate work in their colleges.

Degrees Offered. The following advanced degrees are offered:

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.)

CURRENT GRADUATE DEGREE OFFERINGS (BY COLLEGES)

College of Agriculture

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.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.		
Crops	M.Agr.			
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.			
Soils	M.Agr.			
Soil Science		M.S.		Ph.D.
Wildlife Science	M.Agr.			
Wildlife and Fisheries Sciences		M.S.		Ph.D.

College of Architecture and Environmental Design

Architecture	M.Arch.		D.E.D.	
Construction Management		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.	
Industrial Engineering	M.Eng.	M.S.		Ph.D.
Industrial Hygiene		M.S.		
Industrial Technology		M.S.		
Interdisciplinary Engineering		M.S.		Ph.D.
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.	
Economics	M.S.	Ph.D.
English	M.A.	Ph.D.
History	M.A.	
History (American)		Ph.D.
Political Science	M.A.	
Psychology	M.S.	Ph.D.
Public Administration	M.P.A.	
Sociology	M.S.	Ph.D.
Spanish	M.A.	

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.
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.

Graduate Courses. A graduate course is an advanced course requiring critical analysis and study. Such courses normally require frequent use of the library for reference to papers reporting original research. Five types of graduate instruction are recognized: (1) lecture courses requiring organization by the instructor of material on an advanced level; (2) supervised laboratory courses; (3) seminars for the critical study of an organized field through reports presented by students or instructors; (4) research by individual students under the direction of members of the Graduate Faculty; and (5) professional internships. Undergraduate level courses may be used only as specified in the following pages. Unless special approval is granted by the Dean of the Graduate College, no individual who is not a member of the graduate faculty of Texas A&M University is authorized to teach a graduate course.

Cooperative Graduate Programs. Texas A&M University has executed Memoranda of Agreement pertaining to cooperative graduate programs with the following institutions: 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.

Each graduate student is responsible for becoming familiar with the rules and regulations pertaining to graduate study and the requirements for advanced degrees.

ADMISSION

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.

To be admitted to the Graduate College (except under double registration, which is restricted to Texas A&M University students), an applicant (1) must hold a four-year baccalaureate degree from a college or university of recognized standing; (2) must show promise of ability to satisfactorily pursue advanced study and research; (3) must have had adequate preparation to enter graduate study in the field chosen; and (4) must submit with the application acceptable scores on the General Test of the Graduate Record Examinations (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 and may be substituted for the Graduate Record Examinations for admission to the Doctor of Philosophy degree program of the College of Business Administration, the Master of Public Administration degree program, and the advanced degree programs offered by the Department of Agricultural Economics. 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 Committees will not be required to retake the GRE or GMAT, where used. Approximately six weeks are required for scores to be received by the Graduate College after the tests are administered. Scores made on the GRE or GMAT more than five calendar years prior to application for admission to the Graduate College may not normally be used to satisfy admission requirements.

During 1985-86 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, prospective applicants should write to Graduate Record Examinations, Educational Testing Service, Box 955-R, Princeton, New Jersey 08541; or the Measurement and Research Services, Texas A&M University, College Station, Texas 77843. Students who must take the GMAT may write Educational Testing Service, Box 966-R, Princeton, New Jersey 08541.

Inquiries regarding admission to the Graduate College should be addressed to the Office of Admissions and Records, Texas A&M University, College Station, Texas 77843. Inquiries about facilities for advanced studies, research and requirements for graduate work in specific fields should be addressed to the department in which the principal work is offered.

Departments may have requirements that apply in addition to those of the Graduate College. In such cases, a departmental standard higher than that of the Graduate College (e.g., a higher minimum grade-point average or higher GRE scores for admission) replaces the Graduate College standard.

A formal application is required of all persons seeking admission to the Graduate College. To allow time for processing, the application forms, which are available from the Office of Admissions and Records, should be filed at least six weeks prior to the opening of the semester. Admission to the Graduate College cannot be completed until all the credentials enumerated on the application form have been filed and evaluated. The following application deadlines have been established for all international applicants:

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

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 conference with members of the graduate faculty in planning their work.

Admission to the Graduate College 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.

Admission to the Graduate College normally remains valid for one calendar year only, unless the student during this period engages in active graduate work at Texas A&M University. Extensions of the one year time limit may be granted, if requested in writing by the applicant.

Scholastic Record. The normal requirement for admission to the Graduate College is a record during at least the last two years of full-time academic study which gives evidence of ability to do successful graduate level work.

A student whose academic record is not satisfactory for this purpose or who is changing fields of study may be required to take additional work to strengthen his or her background and 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, the department in which he or she expects to take work may require that the student pass a comprehensive examination covering the basic undergraduate work in that field.

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.

Graduate Students in Non-Degree Status. Students, other than international students (see following section), who hold baccalaureate and advanced degrees and who have not gained admission either to a master's or doctoral degree 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. 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 each semester upon satisfactory academic performance.

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

Graduate Students in Probationary Status. Students who fail initially to qualify for admission to advanced degree programs but who aspire to work for advanced degrees may be given a probationary period in which to demonstrate the ability to do graduate work, if the departments so recommend. Any student who successfully completes a probationary program will be allowed to use for degree credit all course work subject to the approval of the student's Advisory Committee, the Head of the student's

ıajor department, and the Dean of the Graduate College (i.e., approval of the degree ›rogram). International students are not normally accepted on probation.

International Students. A student from another country who seeks admission to ıe Graduate College must meet the same requirements for admission and candidacy as tudents from the United States, including the submission of scores on the GRE, or, in the :ollege of Business Administration or for the Master of Public Administration degree ›rogram, the GMAT. (The Master of Public Administration degree program and the De-›artment of Agricultural Economics accept either the GMAT or the GRE.) In addition, ›rospective students from other countries must demonstrate the ability to speak, write nd understand the English language. Prospective students whose native language is ot English must take the **Test of English as a Foreign Language** (TOEFL), which is dministered by the Educational Testing Service, Princeton, New Jersey, in over 200 enters around the world. A registration form and a "Bulletin of Information for Candi-lates" may be obtained by writing to TOEFL, Educational Testing Service, Princeton, lew Jersey 08541, USA.

All applicants for admission from non-English-speaking countries must present a core of at least 550 on the TOEFL. Further, to ensure that all applicants are able to take ıll advantage of the instructional program at Texas A&M University, **all** students from on-English-speaking countries must make a satisfactory score on a rigorous oral and ›ritten English proficiency examination after their arrival, regardless of their TOEFL cores or other indications of English language facility. Admission to the University is onditioned upon acceptable TOEFL scores and successful completion of the English ›roficiency examination.

No student from another country may be admitted to Texas A&M University as a non-legree student, nor register in non-degree status.

More detailed information about Texas A&M University and particularly about enroll-ıent procedures is incorporated in a pamphlet "Information for Prospective Interna-onal Students," a copy of which may be obtained by writing to the Office of Admissions nd Records, Texas A&M University, College Station, Texas 77843, U.S.A.

REGISTRATION

In Residence Registration. Before the first registration, the student should con-ult the graduate advisor representing the field of his or her major interest. This advisor ›ill assist in planning the student's first registration.

The load for a full-time graduate student or a student holding a fellowship is 12 to 16 ours per semester or six hours per 5½-week summer term. The load for graduate ssistants on one-half time employment is 9 to 12 hours per semester or four hours per ½-week summer term. Recipients of fellowships and assistantships are normally re-uired to register for the course loads specified above.

Resident graduate students who have completed all course work on their degree ›rograms, but who are still engaged in research for their theses or dissertations, must ɜgister for a minimum of four hours of 691 (Research) or 692 (Professional Study) credit ach semester and each 11-week summer semester until all requirements for the degree ave been completed.

Graduate students whose degree requirements include theses, dissertations or re-ords of study, and who plan to graduate at the end of a summer session (i.e., in August), hould always register in the University during the first term of the summer session in ›hich they plan to graduate, even though the completion of their degree requirements ıay necessitate further registration. This applies to both registration in residence and ɜgistration *in absentia*.

Students on Graduate Assistantships must register for the number of hours required ›y the assistantship.

***In Absentia* Registration.** 1. Students in Master's Degree Programs Requiring a Thesis — Students who are enrolled in master's degree programs requiring a thesis and who have completed all course work on their degree programs other than 691 (Research) will register *in absentia* continuously each fall and spring semester for four semester credit hours of 691 credit until all requirements for the degree have been completed. Students who do not comply with this requirement will have their future registrations blocked. They will be allowed to register only after receiving a favorable recommendation from a departmental review committee (not the student's Advisory Committee), the endorsement of the department head, and the approval of the Dean of the Graduate College.

2. Students in Doctoral Degree Programs Requiring a Dissertation or Record of Study — Effective September 1, 1980, students who are enrolled in doctoral degree programs requiring a dissertation or record of study and who have completed all course work on their degree programs other than 691 (Research) or 692 (Professional Study) will register *in absentia* continuously each fall and spring semester for four semester credit hours of 691 or 692 credit (whichever is applicable) until all requirements for the degree have been completed. Students who do not comply with this requirement will have their future registrations blocked. They will be allowed to register only after receiving a favorable recommendation from a departmental review committee (not the student's Advisory Committee), the endorsement of the department head, and the approval of the Dean of the Graduate College.

3. 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 a thesis, dissertation, or record of study and is registered for either 691 or 692 courses, the student may request, in writing, that the department head appoint an alternate Advisory Committee chair during the interim period.

4. 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 granted, 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 Texas A&M 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 degrees from Texas A&M University must meet degree requirements as set forth in the appropriate catalog.

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

1. Members of the Texas A&M University 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 of Texas A&M University normally will not be granted a graduate degree by Texas A&M 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, and the Dean of the Graduate College, and the Vice President for Academic Affairs before the person applies for admission to the Graduate College.
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 at the beginning of a given semester are within 12 hours of graduation or at the beginning of a summer term are within six hours of graduation may apply for admission to the Graduate College provided they meet the GRE requirements and have a B average or better for the last three semesters of course work. Such students must complete their undergraduate work and obtain the bachelor's degree during the first semester or summer term following their admission to the Graduate College. The maximum total credit hour load for double-registered students is 16 hours in the regular semester or six hours in a 5½-week summer term.

A superior undergraduate student is otherwise eligible to enroll in a graduate course for graduate credit only if he or she files a written petition for approval by the Dean of the Graduate College stating that the student is reserving the graduate course for graduate credit. No graduate course may be listed for credit on an undergraduate degree program. Such petitions must be approved by the head of the student's major (undergraduate) department **and** the student's dean.

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 four credit hours per 5½-week summer term.

Course Load Requirements for International (Non-Immigrant) Students. International (non-immigrant) students who do not initially register for the proper number of semester credit hours required by the Immigration Service or who drop credit hours during the semester or summer term may find themselves in an illegal status and subject to deportation.

The law requires that international (non-immigrant) graduate students be registered for a minimum of nine semester credit hours during a regular semester. The only time that an exception may be made in connection with this requirement is during a student's final semester when he or she needs only to register for the minimum number of hours required to satisfy requirements for the degree or the requirements of the Graduate College. At any time during a semester, if a student drops below the minimum requirements indicated above, the student is in illegal status.

The program in the English Language Institute (ELI) is composed of four increments, each of which is equivalent to three semester credit hours. Accordingly, 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 Texas A&M 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 other words, if such students gain entry to the United States in late May because they were admitted to Texas A&M University for the summer session, beginning in either late May or early June, they must enroll for the summer term for which they were admitted by the University. In such cases, graduate students must enroll for a minimum of four semester credit hours per summer term.

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

Texas A&M University is a coeducational university. All counseling services are offered to students based on individual needs or interests without regard to race, color, religion, sex, age, national origin or unrelated physical or mental handicaps.

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, incidental and living expenses will range from approximately $4,800 to $5,400. Total expenses for returning students during an academic year should be slightly less than those for new students. Nonresident students should increase estimated expenses by $1,280 to adjust for nonresident tuition. International students should increase the estimate by $1,970 to adjust for international student tuition. (See the tuition and fee tables in this section.)

Students are expected to meet all financial obligations to the University by designated due dates. Installment payments and credit card payments are not allowed. 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.

FEES

Tuition and fees listed here for the 1985-86 academic year are based on the most current information available at the time of printing and are subject to change.

REQUIRED FEES

Tuition: Resident students pay $4 per semester credit hour, but the total of such charge shall be not less than $50 per semester or $25 per summer term. Nonresident students pay $46 per semester credit hour, and international students pay $69 per semester credit hour.

Building 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 the Memorial Student Center, G. Rollie White Coliseum, Auditoria, Library, Kyle Field Stadium, University Health Center and other campus facilities.

Student Services Fee: All students pay this fee at the rate of $4.60 per semester credit hour (not exceeding $54.50 per semester, $40.88 per quarter or $27.25 per summer term). It covers the services at the Memorial Student Center, medical services and Intramural-Recreational Sports. It also entitles the student to receive *The Battalion* newspaper, reduced admission to many MSC programs and services of the Student Legal Advisor, Student Counseling Service and Student Activities.

Student Center Complex Fee: This $18 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. This card is used for registration, fee collection, financial aid disbursement, laundry service, dining hall authorization, library privileges, etc. There is a $2 charge for summer students not enrolled during the fall and spring semesters.

Late Registration Fee: Students who register (including payment of fees) on the first class day and thereafter pay a late fee of $10.

REQUIRED FEES BASED ON SPECIFIC COURSES

Laboratory Fees: Laboratory fees ranging in amount from $2 to $8 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 Fee: Field trip fees are assessed to cover the cost of providing trips and vary depending on the course taken and expected expenses.

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 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.**
Room Deposit: A deposit of $200 is required to apply for a room in a residence hall. It will be retained as a deposit against damage or late cancellation or to keep the application in the active file. A reservation may be cancelled and the deposit refunded upon request prior to June 1 for the fall semester, December 1 for the spring semester, May 30 for the first summer term and July 6 for the second summer term. Any cancellation after the above dates will result in forfeiture of the deposit.

OPTIONAL FEES

Room: All students living in residence halls are required to pay room rent. Rooms are furnished with beds, mattresses, desks, chairs and dressers. Students are expected to furnish their own pillows, blankets and linens. Room rents include heat, lights and cleaning of common areas. All rooms are air conditioned unless noted in the table below.

	Semester	Summer Term	Quarter
Commons: Aston, Dunn, Krueger, Mosher	$825.00	$267.00	$534.00
Modular halls: Clements, Haas, Hobby, McFadden, Neeley, Underwood	791.00	256.00	512.00
Legett	617.00	200.00	400.00
Suite-type rooms: Fowler, Hughes, Keathley, McInnis, Schuhmacher	589.00	191.00	381.00
Corps-type halls (including Hotard)	535.00	173.00	346.00
Non-air conditioned halls: Hart, Law, Puryear, Walton	332.00	107.00	215.00

Board: Texas A&M University has three student board dining facilities: Duncan, Commons and Sbisa. Residents of Krueger-Dunn-Mosher-Aston-Underwood eat in the cafeteria located in the Commons. Residents in the northwest part of campus eat at Sbisa Dining Center. Sbisa has been remodeled recently to offer students a wide variety of fast foods including hamburgers, pizzas, french fries, fried chicken, soup and sandwiches as well as conventional cafeteria meals. The Corps of Cadets eats "family style" in Duncan

Dining Center for breakfast and dinner and "cafeteria style" at lunch. The cost of the meal plan is the same in all areas.

Three meal plans are offered each semester:

5-day plan - 3 meals each day, Monday-Friday-$643.65
7-day plan - 3 meals each day, Monday-Saturday, breakfast and lunch on Sunday-$690.90
Any 12 plan - Student's choice of 12 meals of the 20 served, Monday-Saturday, breakfast and lunch on Sunday (not applicable to Corps of Cadets)-$624.75

Commons & Sbisa Serving Hours		**Duncan Serving Hours**	
Breakfast	6:15 a.m. - 10:15 a.m.	Breakfast	7:00 a.m.
Lunch	10:15 a.m. - 2:15 p.m.	Lunch	10:15 a.m. - 2:15 p.m.
Dinner	4:15 p.m. - 7:00 p.m.	Dinner	6:30 p.m.

Off-campus students may select the 5-day, 7-day or any 12 meal plan. Off-campus students may be assigned to a particular dining facility depending on space availability.

Laundry: Weekly laundry service costs $88.50 per semester and includes such washable items as shirts, jeans, skirts, sheets, pillowcases and towels. It does not include Corps uniforms or other items which require dry cleaning or special handling such as permanent press items.
Bus Pass: A bus pass costs $44.50 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:

Students living in a residence hall-two semesters-$63
Students living off campus-two semesters-$45
Motorcycle (including mopeds and scooters)-academic year-$30

Football Ticket Books: The ticket book charge is based on the number of home games at $7.50 per game.
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 $7.50 per game plus $15.
***Aggieland* (Yearbook):** This $15 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 charge is for a student directory.

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) $80.00

11-WEEK SUMMER SEMESTER

Students who register for 11-week summer semester courses during first summer term registration are charged the minimum tuition ($50) for a fall or spring semester. The following fees will also be assessed: the maximum Student Services Fee of $54.50, the Student Center Complex Fee of $18 and the Health Center Fee of $15. If students register for additional courses during the second summer term, fees will be adjusted.

TUITION AND REQUIRED FEES TABLE—FALL, SPRING AND 11-WEEK SUMMER SEMESTERS

No. of Hours	Tuition Resident Students	Tuition Nonresident Students	Tuition Internatl. Students	Building Use Fee	Student Services Fee	Student Center Complex	Health Center Fee	Total for Resident Students	Total for Nonresident Students	Total for Internatl. Students
1	$50.00	$ 46.00	$ 69.00	$ 6.00	$ 4.60	$18.00	$ 0.00	$ 78.60	$ 74.60	$ 97.60
2	$50.00	$ 92.00	$ 138.00	$ 12.00	$ 9.20	$18.00	$ 0.00	$ 89.20	$ 131.20	$ 177.20
3	$50.00	$138.00	$ 207.00	$ 18.00	$13.80	$18.00	$ 0.00	$ 99.80	$ 187.80	$ 256.80
4	$50.00	$184.00	$ 276.00	$ 24.00	$18.40	$18.00	$ 0.00	$110.40	$ 244.40	$ 336.40
5	$50.00	$230.00	$ 345.00	$ 30.00	$23.00	$18.00	$ 0.00	$121.00	$ 301.00	$ 416.00
6	$50.00	$276.00	$ 414.00	$ 36.00	$27.60	$18.00	$15.00	$146.60	$ 372.60	$ 510.60
7	$50.00	$322.00	$ 483.00	$ 42.00	$32.20	$18.00	$15.00	$157.20	$ 429.20	$ 590.20
8	$50.00	$368.00	$ 552.00	$ 48.00	$36.80	$18.00	$15.00	$167.80	$ 485.80	$ 669.80
9	$50.00	$414.00	$ 621.00	$ 54.00	$41.40	$18.00	$15.00	$178.40	$ 542.40	$ 749.40
10	$50.00	$460.00	$ 690.00	$ 60.00	$46.00	$18.00	$15.00	$189.00	$ 599.00	$ 829.00
11	$50.00	$506.00	$ 759.00	$ 66.00	$50.60	$18.00	$15.00	$199.60	$ 655.60	$ 908.60
12	$50.00	$552.00	$ 828.00	$ 72.00	$54.50	$18.00	$15.00	$209.50	$ 711.50	$ 987.50
13	$52.00	$598.00	$ 897.00	$ 78.00	$54.50	$18.00	$15.00	$217.50	$ 763.50	$1,062.50
14	$56.00	$644.00	$ 966.00	$ 84.00	$54.50	$18.00	$15.00	$227.50	$ 815.50	$1,137.50
15	$60.00	$690.00	$1,035.00	$ 90.00	$54.50	$18.00	$15.00	$237.50	$ 867.50	$1,212.50
16	$64.00	$736.00	$1,104.00	$ 96.00	$54.50	$18.00	$15.00	$247.50	$ 919.50	$1,287.50
17	$68.00	$782.00	$1,173.00	$102.00	$54.50	$18.00	$15.00	$257.50	$ 971.50	$1,362.50
18	$72.00	$828.00	$1,242.00	$108.00	$54.50	$18.00	$15.00	$267.50	$1,023.50	$1,437.50
19	$76.00	$874.00	$1,311.00	$114.00	$54.50	$18.00	$15.00	$277.50	$1,075.50	$1,512.50
20	$80.00	$920.00	$1,380.00	$120.00	$54.50	$18.00	$15.00	$287.50	$1,127.50	$1,587.50
21	$84.00	$966.00	$1,449.00	$126.00	$54.50	$18.00	$15.00	$297.50	$1,179.50	$1,662.50

Note: Add property deposit, I.D. Card Fee, P.E. Service Fee, laboratory fees and optional fees as necessary.

(The above table is based on the most current information available at the time of printing. Rates are subject to change.)

TUITION AND REQUIRED FEES TABLE—5½-WEEK SUMMER TERMS

No. of Hours	Tuition Resident Students	Tuition Nonresident Students	Tuition Internatl. Students	Building Use Fee	Student Services Fee	Student Center Complex	Health Center Fee	Total for Resident Students	Total for Nonresident Students	Total for Internatl. Students
1	$25.00	$ 46.00	$ 69.00	$ 6.00	$ 4.60	$9.00	$0.00	$ 44.60	$ 65.60	$ 88.60
2	$25.00	$ 92.00	$138.00	$12.00	$ 9.20	$9.00	$0.00	$ 55.20	$122.20	$168.20
3	$25.00	$138.00	$207.00	$18.00	$13.80	$9.00	$7.50	$ 73.30	$186.30	$255.30
4	$25.00	$184.00	$276.00	$24.00	$18.40	$9.00	$7.50	$ 83.90	$242.90	$334.90
5	$25.00	$230.00	$345.00	$30.00	$23.00	$9.00	$7.50	$ 94.50	$299.50	$414.50
6	$25.00	$276.00	$414.00	$36.00	$27.25	$9.00	$7.50	$104.75	$355.75	$493.75
7	$28.00	$322.00	$483.00	$42.00	$27.25	$9.00	$7.50	$113.75	$407.75	$568.75
8	$32.00	$368.00	$552.00	$48.00	$27.25	$9.00	$7.50	$123.75	$459.75	$643.75
9	$36.00	$414.00	$621.00	$54.00	$27.25	$9.00	$7.50	$133.75	$511.75	$718.75
10	$40.00	$460.00	$690.00	$60.00	$27.25	$9.00	$7.50	$143.75	$563.75	$793.75
11	$44.00	$506.00	$759.00	$66.00	$27.25	$9.00	$7.50	$153.75	$615.75	$868.75
12	$48.00	$552.00	$828.00	$72.00	$27.25	$9.00	$7.50	$163.75	$667.75	$943.75

Note: Add property deposit, I.D. Card Fee, P.E. Service Fee, laboratory fees and optional fees as necessary.

(The above table is based on the most current information available at the time of printing. Rates are subject to change.)

MEDICAL SCHOOL FEES

The estimated fees for students in the first two years of the professional curriculum in medicine are shown below:

	Fall Quarter	Winter Quarter	Spring Quarter
Tuition* (statutory amount regardless of course load)	$100.00	$100.00	$100.00
Building Use Fee	102.00	102.00	102.00
Student Services Fee	40.88	40.88	40.88
Student Center Complex Fee	13.50	13.50	13.50
Health Center Fee	11.25	11.25	11.25
Property Deposit	10.00	—	—
Identification Card	5.00	—	—
Laboratory Fee	16.00	16.00	16.00
Microscope Rental Fee	25.00	25.00	25.00
Total	$323.63	$308.63	$308.63

* Nonresident students pay $300 per quarter.

The estimated fees for students in the second two years of the professional curriculum in medicine are shown below:

	Fall Term	Spring Term
Tuition*	$200.00	$200.00
Building Use Fee	96.00	96.00
Student Services Fee	30.00	30.00
Identification Card	5.00	—
Total	$331.00	$326.00

* Nonresident students pay $600 per term.

RESIDENCY

Please read the following rules concerning resident/nonresident status. Your status as a resident, nonresident or international (foreign) student will be determined in the Office of the Registrar prior to your enrollment. You must be prepared to pay tuition and other required fees by specified due dates.

If you have knowledge of an error in your residency status for tuition purposes, it is your responsibility to notify the Office of the Registrar immediately.

Statute: Section (e) The term "residence" as used in this act means "domicile"; the term "resided in" means "domiciled in"; provided, the Governing Board of each institution required under this Act to charge a nonresident registration fee is hereby authorized and directed to follow such rules, regulations, and interpretations as are issued by the Coordinating Board, Texas College and University System, for effective and uniform administration of the nonresident tuition provisions of this Act. For the purposes of this Act, the status of a student as a "resident" or "nonresident" student is to be determined as follows:

I. Minors

Statute: Section 54.052 (b) An individual, under eighteen (18) years of age, who is living away from his family, and whose family resides in another state or who has not resided in Texas for the 12-month period immediately preceding the date of registration shall be classified as a nonresident student;

Section 54.052 (c) An individual eighteen (18) years of age or under whose family has not resided in Texas for the 12-month period immediately preceding the date of registration shall be classified as a nonresident student regardless of whether he has become the legal ward of residents of Texas or has been adopted by residents of Texas while he is attending an educational institution in Texas, or within a 12-month period before his attendance, or under circumstances indicating that the guardianship or adoption was for the purpose of obtaining status as a resident student;

Section 54.055 An individual eighteen years of age or under whose parents were formerly residents of Texas is entitled to pay the resident tuition fee following the parents' change of legal residence to another state, as long as the individual remains continuously enrolled in a regular session in a state-supported institution of higher education.

Death or divorce of parents.—The legal residence of a minor under eighteen years of age is usually that of the father. Upon the death of the father, the legal residence of the minor is that of the mother. Upon divorce or legal separation of the parents, the residence of the minor is determined by the residence of the parent with whom the minor is making his home at the time of registration.

Custody by court order.—If the custody of the minor had been granted by court order (e.g., divorce decree, child custody action, guardianship or adoption proceedings) to some person other than the parent, the residence of that person shall control; provided, however, that such grant of custody was not ordered during or within a year prior to the minor's enrollment in an institution of higher education (defined as any public junior college, public senior college or university, medical or dental unit, or other agency of higher education) and was granted under circumstances indicating that such guardianship was not for the purpose of obtaining status as a resident student.

If the minor is not making his home with either parent, and there is no court-appointed guardian, the residence of the parent with whom the minor last resided shall be presumed to control. If, however, the minor has made his home with, and has been dependent upon, a grandparent for more than a year prior to enrollment in an institution of higher education, the residence of that natural guardian shall be regarded as his residence. The residence of a person other than a parent or natural or legal guardian, who may furnish funds for payment of tuition, fees, or living expenses, shall in no way affect the residence classification of a minor.

Abandoned child.—In the case of an abandoned child, the residence of a person who has stood *in loco parentis* for a period of time may determine the residence of such abandoned child. The fact of abandonment must be clearly established, and must not have been for the purpose of affecting the residence of the minor, and the minor must have actually resided in the home of such person for two years immediately prior to registering in an institution of higher education in Texas and must have received substantially all of his support from such person. In the event that the *in loco parentis* relationship has not existed for the full two-year period, a lesser period of time is acceptable in unusual hardship cases, such as death of both parents.

Orphan.—An orphan who has lived for longer than a year in an established orphans' home in Texas operated by a fraternal, religious, or civic organization and has been graduated from the orphans' home shall be considered a resident of Texas provided he remains in Texas from the time of such graduation until he enters an institution of higher education.

Emancipated child.—Under certain circumstances, a minor may become emancipated or freed from parental control. If the minor's parents have ceased to exercise parental control and responsibility, if the minor is responsible for all of his or her own decisions and affairs, and if the minor is financially independent of parents, the minor may establish emancipation. A minor is financially independent if he or she receives less than $600 a year from parents, and if the parents do not claim the minor as a dependent. If emancipation is clearly proven, the residence classification of the minor is determined by the residence of the minor rather than the residence of the parents, and after twelve months in Texas under such circumstances, the minor may be classified as a resident, if he or she otherwise satisfies the statutory requirements applicable to those over eighteen (e.g., see presumption arising from residence while a student). Proof of emancipation is the responsibility of the minor.

Married minors.—A minor who is married shall have the power and capacity of a single person of full age and is entitled to select his or her own place of legal residence. After twelve months' residence in Texas under such circumstances, the minor may be classified as a resident if he or she otherwise satisfies the statutory requirements applicable to those over eighteen years of age. The residence classification for tuition purposes of a nonresident who marries a Texas resident shall be

governed by the provisions of the tuition statute (Texas Education Code, Sec. 54.056) and of these rules and regulations as hereinafter set out.

Minors whose parents moved to another state or foreign country.—If the parents of a minor who is enrolled as a resident student move their legal residence to another state or foreign country on, or after, August 15, 1971, the minor shall be classified as a nonresident at all subsequent registration periods. Under the provisions of Section 54.055, the minor will be entitled to pay the resident fee as long as he remains continuously enrolled in a regular session in a Texas public institution of higher educaton or secondary education listed and approved by the Texas Education Agency. The minor student must reenroll for the next available regular semester immediately following the parents' change of legal residence to another state.

If the parents of a minor move to another state or foreign country, or reside outside the state or in a foreign country at the time of enrolling in an institution of higher education, but claim legal residence in Texas, conclusive evidence must be presented that the parent is still claiming legal residence in the State of Texas and has the present intent to return to the state. A certificate from the employer of the parents that the move outside the state was temporary and that there are definite plans to return the parents to Texas by a determinable future date may be considered in this connection.

If a minor whose parents have moved their legal residence to another state or foreign country resides in Texas for twelve consecutive months following his eighteenth birthday and by his action clearly indicates that his intention is to establish permanent residence in the state, he may be classified as a resident student, effective with the beginning of the term or semester following his nineteenth birthday despite the fact that his entire period of residence in Texas has been as a student.

When the parents of a minor who have established their legal residence in another state or foreign country return and reestablish their legal residence in Texas, the minor must be classified as a nonresident until the first registration after the parents have resided in the state for a twelve-month period following their return.

II. Residence of Individuals over Eighteen

Statute: Section 54.052 (d) An individual eighteen (18) years of age or over who has come from outside Texas and who resides in Texas for a 12-month period immediately preceding registration in an educational institution shall be classified as a resident student as long as he continues to maintain a legal residence in Texas; and

Section 54.052 (e) An individual eighteen (18) years of age or over who resides out of state or who has come from outside Texas and who registers in an educational institution before having resided in Texas for a 12-month period shall be classified as a nonresident student.

Section 54.054 A nonresident student classification is presumed to be correct as long as the residence of the individual in the state is primarily for the purpose of attending an educational institution. After residing in Texas for at least twelve (12) months, a nonresident student may be reclassified as a resident student as provided in the rules and regulations adopted by the Coordinating Board, Texas College and University System. Any individual reclassified as a resident student is entitled to pay the tuition fee for a resident of Texas at any subsequent registration as long as he continues to maintain his legal residence in Texas.

Establishment of residence.—Any individual eighteen years of age or over who moves into the state and who resides within the state while gainfully employed for a period of twelve months prior to enrolling in an educational institution (defined as an institution of higher education, public or private, above the high-school level) is entitled to classification as a resident. If such twelve months' residence, however, can be shown not to have been for the purpose of establishing legal residence in the state but to have been for some other purpose, the individual is not entitled to be classified as a resident. Any student registering in an educational institution prior to having resided in the state for twelve months shall be classified as a nonresident for tuition purposes.

A person classified as a nonresident student upon first enrollment in an institution of higher education is presumed to be a nonresident for the period during which he or she continues as a student. If such nonresident withdraws from school and resides in the state while gainfully employed for a period of twelve months, upon reentry into an institution of higher education the student will be entitled to be reclassified as a resident for tuition purposes. Accumulations of summer and other vacation periods do not satisfy this requirement. Reclassification to residence status after residing in the state for twelve months cannot be based solely upon the student's or the student's spouse's employment, registration to vote, registration of a motor vehicle and payment of personal property taxes thereon, or the securing of a Texas driver's license. The presumption of a "nonresident" is not a conclusive presumption, however, and other facts may be considered to determine if the presumption has been overcome. Material to this determination are business or personal facts or actions

unequivocally indicative of a fixed intention to reside permanently in the state. Such facts may include, but are not limited to, the length of residence and full-time employment prior to registering in the institution, the fact of full-time employment and the nature of such employment (regular industrial, business, or professional employment as distinguished from student-type employment) while a student, purchase of a homestead with substantial down payment, dependency upon a parent or guardian who has resided in Texas for at least twelve months immediately preceding the student's registration, and marriage to a resident of Texas. All of these facts are weighed in the light of the fact that a student's residence while in school is primarily for the purpose of education and not to establish residence and that decisions of an individual as to residence are generally made after the completion of an education and not before.

III. Married Students

Statute: Section 54.056 A nonresident who marries and remains married to a resident of Texas classified as such under this Act at the time of the marriage and at the time the nonresident registers, is entitled to pay the resident tuition fee regardless of the length of time he has lived in Texas, and any student who is a resident of Texas who marries a nonresident is entitled to pay the resident tuition fee as long as he does not adopt the legal residence of the spouse in another state.

Nonresident who marries a resident of Texas.—The nonresident male or female student who marries a resident of Texas is entitled to pay the resident tuition at the registration period next following the date of marriage upon submission of evidence of such marriage and of the spouse's legal residence in Texas. Such marriage evidence is a certified copy of the marriage license or other certified, documentary evidence of marriage as filed with the county clerk. The legal residences of a husband and wife are normally presumed to be the same; however, it is possible for either the husband or wife to establish a residence different from the other spouse. In such a situation, the normal standards are followed. (See II.)

In the event a nonresident male or female student who marries a resident of Texas subsequently is divorced, such nonresident student shall be classified as a nonresident for all enrollment periods subsequent to the date of such divorce.

IV. Military Personnel and Veterans

Statute: Section 54.058 (a) Military personnel are classified as provided by this section in the following manner:

(b) An officer, enlisted man or woman, selectee or draftee of the Army, Army Reserve, Army National Guard, Air National Guard, Texas State Guard, Air Force, Air Force Reserve, Navy, Navy Reserve, Marine Corps, Marine Corps Reserve, Coast Guard, or Coast Guard Reserve of the United States who is assigned to duty in Texas is entitled to register himself, his spouse, and their children in a state institution of higher education by paying the tuition fee and other fees or charges required of Texas residents, without regard to the length of time he has been assigned to duty or resided within the state. However, out-of-state Army National Guard or Air National Guard members attending training with Texas Army or Air National Guard units under National Guard Bureau regulations may not be exempted from nonresident tuition by virtue of that training status nor may out-of-state Army, Air Force, Navy, Marine Corps, or Coast Guard Reserves training with units in Texas under similar regulations be exempted from nonresident tuition by virtue of such training status. It is the intent of the legislature that only those members of the Army or Air National Guard, Texas State Guard, or other reserve forces mentioned above be exempted from the nonresident tuition fee and other fees and charges only when they become members of Texas units of the military organizations mentioned above.

(c) As long as they reside continuously in Texas, the spouse and children of a member of the Armed Forces of the United States who has been assigned to duty elsewhere immediately following assignment to duty in Texas are entitled to pay the tuition fees and other fees or charges provided for Texas residents;

(d) If nonresident military personnel are attending an institution of higher education under a contract between the institution and any branch of the Armed Forces of the United States, in which the tuition of the member of the military is paid in full by the United States Government, the student shall pay the resident tuition fee;

(e) The spouse and children of a member of the Armed Forces of the United States who dies or is killed are entitled to pay the resident tuition fee, if the wife and children become residents of Texas within sixty days of the date of death; and

(f) If a member of the Armed Forces of the United States is stationed outside Texas and his spouse and children establish residence in Texas by residing in Texas and by filing with the Texas institution of higher education at which they plan to register a letter of intent to establish residence in Texas, the institution of higher education shall permit the spouse and children to pay the tuition, fees, and other charges provided for Texas residents without regard to length of time they have resided within the State.

A. Certification of assignment to duty in Texas.—Subsection (b) provides that military personnel assigned to duty within the State of Texas, their husband or wife as the case may be and their children, shall be entitled to pay the same tuition as a resident of Texas regardless of the length of their physical presence in the state. To be entitled to pay the resident tuition fees, such military personnel shall submit at the time of each registration a statement from his commanding officer or personnel officer certifying that he is then assigned to duty in Texas and that same will be in effect at the time of such registration in an institution of higher education. This subsection also provides that a nonresident member of an out-of-state National Guard unit who is temporarily training with a Texas National Guard unit will not be entitled to pay the resident tuition.

B. Spouse and children of members of armed forces.—Subsection (c) provides that the spouse and children of a member of the armed forces assigned to duty outside the State of Texas immediately after assignment in Texas may be entitled to pay the resident tuition as long as they reside continuously in Texas.

Subsection (f) provides that the spouse and children of a member of the armed forces who is assigned to duty outside the State of Texas and sends his family to the State of Texas may be entitled to pay the resident tuition if they file with the institution of higher education at which the student intends to register a letter of intent, an affidavit, or other evidence satisfactory to the institution stating that they intend to become permanent residents of Texas.

Subsection (e) provides that a member of the immediate family (which shall include spouse or children) of a member of the armed forces who dies or is killed in action while in military service may qualify to pay the resident tuition if they become residents of Texas within sixty days of the date of death. To qualify under this provision, the student shall submit to the institution of higher education satisfactory evidence establishing the date of death and residence in Texas.

The military personnel spouse and children enumerated in (b), (c), (e), and (f) are classified as nonresidents but shall be entitled to pay the resident tuition regardless of the length of residence in Texas if they comply with the provisions of the statute and these rules and regulations.

C. Legal residence of person in military service.—A person in military service is presumed to maintain during his entire period of active service the same legal residence which was in effect at the time he entered military service. A person stationed in a state on military service is presumed not to establish a legal residence in that state because his presence is not voluntary but under military orders. It is possible for a member of the military service to abandon his domicile of original entry into service and to select another, but to show establishment of a new domicile during the term of active service, there must be clear and unequivocal proof of such intent. An extended period of service alone is not sufficient. The purchase of residential property is not conclusive evidence unless coupled with other facts indicating an intent to put down roots in the community and to reside there after termination of military sevice. Evidence which will be considered in determining this requisite intent includes, but is not limited to, a substantial investment in a residence and the claiming of a homestead exemption thereon, registration to vote, and voting in local elections, registration of an automobile in Texas and payment of personal property taxes thereon, obtaining a Texas driver's license, maintaining checking accounts, savings acounts, and safety deposit boxes in Texas banks, existence of wills, or other legal documents indicating residence in Texas, change of home-of-record and designation of Texas as the place of legal residence for income tax purposes on military personnel records, business transactions or activities not normally engaged in by military personnel, membership in professional or other state organizations, and marriage to a resident of Texas. Purchase of property during terminal years of military service preceding retirement generally is given greater weight than a similar purchase made prior to such a terminal period.

D. Residence classification of veterans upon separation from military service.—A person who enrolls in an institution of higher education following separation from military service must be classified as a nonresident student unless (1) the individual was a legal resident of Texas at the time of entry into military service and has not relinquished that residence, (2) the individual can prove that during military service he or she has, in fact, established a *bona fide*, legal residence in Texas at a time at least twelve months prior to registration, or (3) the individual has resided in Texas other than as a student for twelve months prior to registration and subsequent to discharge from service. The nonresident classification is a presumption, however, which can be overcome pursuant to the guidelines and standards for establishing Texas residence. (See II.)

V. Employees of Publicly Supported Texas Institutions of Higher Education Other than Students

Statute: Section 54.059 A teacher, professor, or other employee of an institution of higher education is entitled to register himself, his spouse, and their children in an institution of higher education by paying the tuition fee and other fees or charges required for Texas residents without regard to the length of time he has resided in Texas. A teacher, professor, or other employee of an institution of higher education is any person employed at least one-half time on a regular monthly salary basis by an institution of higher education.

A person employed at least half-time on a regular monthly salary basis (not an hourly employee) by any publicly supported Texas institution of higher education, with an effective date of employment on or before the twelfth class day of a regular semester or the fourth class day of a summer term and an ending date of employment no earlier than the last official class day, may pay the same tuition as a resident of Texas for self, husband or wife as the case may be, and their children, regardless of the length of residence in the state. To be entitled to pay the resident fees a request form for exemption from nonresident tuition, certified by the employee, the employing department, and the student, must be submitted to the student financial services division of the Fiscal Department prior to each registration.

VI. Student Employees

Statute: Section 54.051 (o) A teaching assistant, research assistant, or other student employee of any institution covered by this section is entitled to register himself, his spouse, and their children in a state institution of higher education by paying the tuition fees and other fees or charges required for Texas residents, without regard to the length of time he has resided in Texas; provided that said student employee is employed at least one-half time in a position which relates to his degree program under rules and regulations established by the employer institution. This exemption shall continue for students employed two consecutive semesters through the summer session following such employment if the institution is unable to provide employment and, as determined under standards established by the institution, if the employee has satisfactorily completed his employment.

A student employed at least half-time by any publicly supported Texas institution of higher education in a position which relates to his degree program, with an effective date of employment on or before the twelfth class day of a regular semester or the fourth class day of a summer term and an ending date of employment no earlier than the last official class day, may pay the same tuition as a resident of Texas for himself, the husband or wife as the case may be, and their children, regardless of the length of residence in the state. The institution which employs the student shall determine whether or not the student's job relates to his degree program. If a student is employed by a publicly supported Texas institution of higher education for consecutive fall and spring semesters and he was further eligible to pay the tuition charged to Texas residents during those fall and spring semesters because of the provisions of this subsection, then the student may continue to pay the resident tuition rate during the summer session following the spring employment if the institution is unable to provide employment and if the student has satisfactorily completed his employment. Also, a student may qualify for exemption from nonresident tuition for the entire summer session on the basis of eligible employment for one or more summer terms. To be entitled to pay the resident fees a request form for exemption from nonresident tuition, certified by the student, the employing department, and the academic dean, must be submitted to the student financial services division of the Fiscal Department prior to each registration.

VII. Competitive Scholarships

Statute: Section 54.051 (p) A student who holds a competitive scholarship of at least $200 for the academic year or summer for which he is enrolled and who is either a nonresident or a citizen of a country other than the United States of America is entitled to pay the fees and charges required of Texas residents without regard to the length of time he has resided in Texas, provided that he must compete with other students, including Texas residents, for the scholarship and that the scholarship must be awarded by a scholarship committee officially recognized by the administration of the institution of higher education.

An official scholarship committee or committees of a public institution of higher education may award competitive scholarships in amounts of $200 or more for the academic year, the summer session, or both. If a nonresident student or a student who is a citizen of a country other than the United States obtains one of these competitive scholarships, he may pay the same tuition as a

resident of Texas during the registration period in which the scholarship is in effect. The student must present a statement from the official scholarship committee certifying that such scholarship will be in effect at the time of registration.

VIII. Citizens of Any Country Other than the United States of America

Statute: Section 54.057 An alien who is living in this country under a visa permitting permanent residence or who has filed with the proper Federal immigration authorities a declaration of intention to become a citizen has the same privilege of qualifying for resident status for fee purposes under this Act as has a citizen of the United States. A resident alien residing in a junior college district located immediately adjacent to Texas boundary lines shall be charged the resident tuition by that junior college.

An alien living in the United States under a visa permitting permanent residence, or one who has filed with the proper Federal authorities a declaration of intention to become a citizen, has the same privilege of qualifying for Texas resident status for tuition purposes as has a citizen of the United States.

Statute: Section 54.051 (h) Tuition for students who are citizens of any country other than the United States of America is the same as tuition required of other nonresident students.

Statute: Section 54.051 (i) Tuition for students who are citizens of any country other than the United States of America registered in a medical or dental branch, school, or college is the same as tuition required of other nonresident students.

IX. Student Responsibilities

Student responsibility to register under proper classification.—The responsibility of registering under the proper residence classification is that of the student, and if there is any question of his right to classification as a resident of Texas, it is his obligation, prior to or at the time of his registration, to raise the question with the administrative officials of the institution in which he is registering and have such officially determined.

Notification upon becoming a nonresident.—Every student who is classified as a resident student but who becomes a nonresident at any time by virtue of a change of legal residence by his own action or by the person controlling his domicile is required to notify the proper administrative officials of his institution at once.

X. Official Change of Residence Status

Application for reclassification.—Every student classified as a nonresident student shall be considered to retain that status until such time as he shall have made written application for reclassification in the form prescribed by the institution and shall have been officially reclassified in writing as a resident of Texas by the proper administrative officers of the institution.

Reclassification as a nonresident.—Every person who has been classified as a resident of Texas shall be reclassified as a nonresident student whenever he shall report, or there is found to exist, circumstances indicating a change in legal residence to another state. If any student who has been classified as a resident of Texas shall be found to have been erroneously so classified, he shall be reclassified as a nonresident and shall be required to pay the difference between the resident and nonresident fees for such semesters in which he was so erroneously classified. In addition, he shall be required to pay back all monies borrowed from the Texas Opportunity Plan Fund.

Reclassification as a resident.—If any student has been erroneously classified as a nonresident student and subsequently proves to the satisfaction of the appropriate officials of an institution of higher education that he should have been classified as a resident student, he shall be reclassified as a resident of Texas and shall be entitled to a refund of the difference between the resident and nonresident fees for the semesters in which he was erroneously so classified.

XI. Penalties

Statute: Section 54.053 The governing board of each institution required by this Act to charge a nonresident tuition or registration fee is subject to the rules, regulations, and interpretations issued by the Coordinating Board, Texas College and University System, for the administration of the nonresident tuition provisions of this Act. The rules, regulations, and interpretations promulgated by the Coordinating Board shall be furnished to the presidents or administrative heads of all Texas public senior and junior colleges and universities.

Section 54.061 The governing board of an institution of higher education may assess and collect from each nonresident student who fails to comply with the rules and regulations of the boards concerning nonresident fees a penalty not to exceed $10 a semester.

Student compliance with institutional rules and regulations.—Each institution has been authorized by statute to assess and collect from each nonresident student failing to comply with the provisions of the tuition statute and with these interpretations concerning nonresident fees a penalty not to exceed $10 a semester. In addition, if a student has obtained residence classification by virtue of deliberate concealment of facts, or misrepresentation of fact, he may be subject to appropriate disciplinary action, in accordance with the rules and regulations that may be adopted by the governing boards of the respective institutions of higher education.

WITHDRAWAL FROM THE UNIVERSITY

Once a fee payment 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 in future enrollment in the University.

REFUNDS

Refund of fees shall be made to students officially withdrawing from the University according to the following withdrawal schedule:

Tuition, Student Services Fee, Building Use Fee, Student Center Complex Fee, Health Center Fee, P.E. Service Fee, Laboratory Fee and Residence Hall Rent

Fall, Spring or 11-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

5½-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

Residence Hall Rent: If a student withdraws, moves off campus or in any other way terminates the housing contract, a refund of residence hall rent will not be made unless the room is rerented within 10 days to a student residing in other than University-owned property. If the room is rerented within this 10 day period to a student not residing in University-owned property, refund will be made in accordance with the above schedule.
Laundry Fee: Laundry fees are refundable in full prior to the first day of classes. After classes begin no refunds will be made except in case of official withdrawal at which time a pro rata refund computed on a weekly basis will be made.

In case of consecutive absence of 10 or more days due to illness of the student or family member or for some other unavoidable cause, a pro rata refund computed on a weekly basis will be made.

Board: Students may withdraw from the board plan at any time by application to the Department of Food Services. Board fees will be refunded in full on requests received prior to the first day of classes. Refunds on requests received after classes begin will be prorated on a daily basis, less a withdrawal fee equal to 10 percent of the semester board rate.
Identification Card Fee: After the card is issued, none of this fee can be refunded.
Shuttle Bus Fee: Shuttle bus fees are refundable in full prior to the first day of classes. After classes begin, refunds will be prorated on a weekly basis through the fourth week of a fall or spring semester and through the first week of a summer term or an 11-week summer semester. After these deadlines, refunds will only be made in case of official withdrawal, and they will also be prorated on a weekly basis.
Yearbook Fee: Yearbook fees 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.

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 an 11-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 summer term or an 11-week summer semester. Full refunds or supplemental billings will be made for courses dropped or added during these times. Notices of refunds due or amounts owed 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 of room rent and 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.

FEE RECEIPTS

Your fee receipt is your official record of enrollment at the University and allows you to receive services to which you are entitled based on payment of fees. **You must bring your fee receipt with you to campus and keep it in your possession.**

CASH NEEDS

It is recommended that students have a checking account to meet cash and other financial needs while attending the University. Students having MPACT and PULSE cards may use the automatic teller machines located near the east entrance to the MSC. Students may also cash personal checks for up to $25 at the main desk of the MSC.

MARRIED STUDENT APARTMENTS

University-owned apartments, both furnished and unfurnished (in limited numbers), are available to married students. Rentals range from $165 to $260 per month. Utilities, except electric power, are paid for by the University. (Tenants pay for electric power used in all apartments except those in the Southside complex, where the tenants pay for electric power used by major appliances.) Application for a married student apartment should be made directly to the Student Apartments Office, Box 117, University Mail Service, College Station, Texas 77843.

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, carpool referrals and other information pertinent to the off campus student. A roommate locator service is available to help students find a person with whom to live. 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, laundry 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, 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.

DEGREE PROGRAM

A graduate student's degree program includes those courses which are listed for degree credit on the official form. All courses on the approved degree program must be completed with a satisfactory grade to meet requirements for the degree. Changes in an approved degree program can be made by petition to the Dean of the Graduate College approved by the student's full Advisory Committee.

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

SCHOLARSHIP

A minimum grade point ratio (GPR) of 3.0 (B average based on a 4.0 maximum) in all course work other than in those courses in which grades of Satisfactory (S) or Unsatisfactory (U) are given (681, 684, 690, 691, 692, 695) must be maintained throughout the period of graduate study by every graduate student at Texas A&M University. All grades earned in courses listed for graduate credit on the student's official degree program will be used in computing the grade point ratio. Grades of D, F, or U for courses on a degree program must be absolved by repeating the course and achieving a grade of C or above.

A course in which the final grade is C or less may be repeated for a higher grade, in which event both or all grades earned and the total number of semester hours represented by the course will be used in the computation of the grade point ratio. Semester credit hours to which grades of WF and F are assigned shall be included; those involving grades of WP and Q shall be excluded. Grades and semester hours of credit transferred to a proposed degree program from another institution shall be used in computing the student's final over-all GPR.

Courses listed for graduate credit on the approved degree program in which the student has received a final grade may not normally be removed from the degree program, although courses acceptable for graduate credit may be added. Exceptions to the regulation set forth in the preceding sentence may be petitioned. Petitions must be approved by all members of the student's Advisory Committee, the head of the student's major department, and the Dean of the Graduate College.

If a student's cumulative GPR falls below the minimum of 3.0, the student 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 the Graduate College. A grade of C is the lowest grade for which graduate credit will be given. Courses in which grades of S or U are given, only the S grade is acceptable toward the completion of a degree program. No courses taken on a satisfactory/unsatisfactory basis may be used for graduate credit.

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.

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 Graduate College. 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.

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.

By definition, 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 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.

PETITIONS

Exceptions to published rules may be requested by proper petition to the Dean of the Graduate College. If regarded as fully justifiable on the basis of the facts presented, limited exceptions to some rules may be approved.

Any changes in membership of a student's Advisory Committee, degree program, etc., must be proposed to the Dean of the Graduate College by petition, with endorsements by all members and, when applicable, proposed members of the student's Advisory Committee.

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, nine credit hours during one semester or during two consecutive 5½-week summer terms. Upon recommendation of the student's Advisory Committee and the approval of the Dean of the Graduate

College, a student may be granted exemption from the requirement of nine credit hours to be taken during one semester or during two consecutive 5½-week summer terms. 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. In this context a full course load is considered to be nine credit hours per semester, or nine credit hours per 11-week summer session. 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 the Graduate College and enrolling for graduate studies, 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 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 the student's Advisory Committee. The student will then personally interview each prospective committee member to determine whether he or she will accept the assignment. No individual located away from the campus of Texas A&M University 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 at College Station.

The committee members' signatures on the approved degree program 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 program, 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 Dean of the Graduate College.

Degree Program

The student's Advisory Committee, in consultation with the student, will develop the proposed degree program. **This should be completed and filed with the Dean of the Graduate College, whose approval is required, prior to the second semester's registration.**

This proposed degree program must be submitted on the official form with endorsements by the student's Advisory Committee and the head of the student's major department.

Students submitting proposed degree programs for Master of Science degrees should designate at the top of the official proposed degree program 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 program by the student's Advisory Committee if such additional course work is deemed necessary to correct deficiencies in the student's academic preparation.

Credit Requirement

A minimum of two full semesters of approved courses and research (32 semester hours) 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 field 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. Not more than a total of six credit hours of transfer course work. Only course work taken in residence at an accredited institution will be considered for transfer credit. No course in which the grade is below B may be transferred for graduate credit. **(Note also b and d, below).**
   b. Not more than a total of 12 credit hours of course work taken by extension, including 685 (Problems) taken by a student 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 extension courses taken under the direction of Texas A&M University. Extension courses taken at institutions other than those within The Texas A&M University System are not acceptable for transfer credit.
   c. Not more than a total of 12 credit hours of 689 (Special Topics).
   d. Not more than a total of 12 credit hours of **any combination** of (1) transfer credit for course work taken at an accredited institution, (2) credit for course work taken by extension, and (3) 689 (Special Topics).
2. Not more than eight hours each of 691 (Research), or 685 (Problems), nor more than three hours of 690 (Theory of Research) or 695 (Frontiers in Research) — nor more than 12 hours of any combination of these. All thesis programs are expected to carry a reasonable amount of 691 (Research).
3. Not more than two hours of seminar.
4. Not more than eight hours of advanced undergraduate courses (300 or 400 designation).
5. No credit may be obtained by correspondence study, or for any course of fewer than three weeks duration.
6. No credit hours of 684 (Professional Internship) may be used for the degree of Master of Science.
7. Selected courses offered by the College of Medicine may be used for graduate credit. A maximum of twelve semester credit hours of such course work may be used for credit on a minimal master's degree program. For a listing of approved courses offered by the College of Medicine, the student should see the head of his or her major department, the Dean of the College of Medicine, or the Dean of the Graduate College.

Exceptions will be permitted only in unusual cases and only when recommended by the student's Advisory Committee and approved by the Dean of the Graduate College.

Transfer of Credit

A student who has earned 12 hours of graduate resident credit at Texas A&M University may be authorized, upon the advice of the Advisory Committee and with the advance approval of the Dean of the Graduate College, to transfer from another institution more than six hours of specified courses, **if these courses are not available at Texas A&M University.** Otherwise the limitations stated in the preceding section (see 1) apply.

Courses for which transfer credits are sought must have been completed with grades of B or better, and must be approved by the student's Advisory Committee and the Dean of the Graduate College. Credit for thesis or dissertation research 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.

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 for the approval of the Dean of the Graduate College at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive the degree.

Thesis

An acceptable thesis is required for the degrees of Master of Arts (thesis option) and Master of Science (thesis option) and is optional for the degree of Master of Urban Planning. The thesis must be the original work of the candidate. It 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. An abstract not exceeding 350 words and a vita page are included in the thesis. **Instructions relating to specific requirements may be obtained from the office of the Dean of the Graduate College.**

Three copies of the thesis in its final form must be filed with the thesis/dissertation clerk of the Graduate College (University Library), after approval by the student's Advisory Committee and the head of the student's major department, by deadline dates announced each semester or summer session in the "Graduate College Calendar" (See Time Limit statement on page 000).

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.

Credit for Work *in Absentia*

Upon recommendation of the Advisory Committee and approval of the Dean of the Graduate College, a student may be permitted to carry on work in connection with the thesis *in absentia*. For details concerning *in absentia* registration, see section on "Registration."

Time Limit

No student will be granted a master's degree from Texas A&M University unless all requirements for the degree are completed within a period of seven consecutive years. Graduate credit for any 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 Graduate College 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 the Dean of the Graduate College not 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 deadline dates announced each semester or summer session in the "Graduate College Calendar." At the time of the final examination, a student's GPR must be **at least 3.0; furthermore, there must be no unabsolved grades of D, F, or U (unsatisfactory) for any course listed for degree credit on the student's degree program.** To absolve a deficient grade, a student must repeat the course and achieve a grade of C or above. Otherwise the student is **not eligible** to take the final examination. The announcement of the final examination should be submitted to the Graduate College at least two weeks in advance of the scheduled date for the examination. A student must have completed all course work on his or her degree program with the exception of any remaining 691 (Research) hours (for which the student must be registered) and must have an approved research proposal on file with the Graduate College before he or she is eligible to take the final examination.

The final examination covers the thesis and all work taken on the degree program and at the option of the committee may be written or oral or both. The final examination (thesis option) 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 of the Advisory Committee 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.

Candidates may exempt the final examination provided their GPR for the course work completed is equal to 3.5 or better and provided the exemption has the approval of the student's Advisory Committee, the head of the student's major department, and the Dean of the Graduate College.

Students must be registered in the University in the semester or summer session in which the examination is to be given.

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).

Students whose degree requirements include a thesis 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 in which they plan to graduate, even though degree requirements may make it necessary for them to register in the second term also.

Unless otherwise authorized by the Dean of the Graduate College, the final examination for the master's degree must be administered on the campus of Texas A&M University at College Station, Texas.

Non-thesis Option

In departments of the University which wish to do so and which are authorized to offer Master of Science degree programs, 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 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 program.

No hours of 691 (Research) may be counted toward the non-thesis option Master of Science degree; furthermore, students pursuing the non-thesis option are not allowed to enroll in 691 (Research) for any reason. 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 program of study leading to the degree of Master of Agriculture is designed to serve those who desire graduate professional training in an agricultural discipline. A student holding a baccalaureate degree or a qualified senior during his or her last semester may apply for admission to the Graduate College to work toward 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 department of the College of Agriculture and also in the interdisciplinary areas of 1) agricultural chemistry, 2) food science and technology, 3) natural resource development, 4) plant protection and 5) agricultural development.

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

Approximately 12 of the minimum of 36 required credit hours will be taken outside of the student's option. Each candidate will normally be required to prepare one or more written reports (not necessarily involving results of research conducted by the candidate) in addition to papers required as a part of regular course work.

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 Agriculture — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual degree program.

The announcement for the final examination must be submitted to the Graduate College 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 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.**

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

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 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 Graduate College. 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 8 credit hours each of 684 (Professional Internship), 685 (Problems), or 692 (Professional Study), nor more than 3 credit hours each of 690 (Theory of Research), or 695 (Frontiers in Research) may be used toward the degree of Master of Architecture—nor any combination of 684, 685, 690, 692 and 695 (Frontiers in Research) totaling in excess of 16 SCH of these courses in the 52-SCH master's degree program or 11 SCH of these courses in the 36-SCH 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 program.

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.

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 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 may be counted toward the degree. The proposed degree program 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 proposed degree programs for Master of Arts degrees should designate at the top of the official degree program 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 wish to do so and 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 program.

No hours of 691 (Research) may be counted toward the non-thesis option Master of Arts degree; furthermore, students pursuing the non-thesis option are not allowed to enroll in 691 (Research) for any reason. 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.). The M.B.A. program includes a curriculum that emphasizes instruction in the basic disciplines and business functions while recognizing the environmental context within which organizational decisions are made. The M.B.A. degree includes 48 semester credit hours of course work. Holders of bachelor's degrees in business administration admitted prior to the fall semester, 1984, may be allowed to omit some of the required course work at the discretion of the M.B.A. Program Director and a graduate faculty committee. Programs for such students will consist of not less than 36 semester credit hours of course work. All persons must have completed calculus and economics (macro and micro) **prior** to enrollment in the programs. Students admitted for the fall semester, 1984, and thereafter, will be assigned programs consisting of a minimum of 48 semester credit hours.

The M.B.A. degree program is designed for full time students and includes 36 semester hours of required courses. The 12 semester hours of elective courses may be taken in elective blocks drawn from the professional fields of accounting, business computing science, finance, management or marketing or a student may select an elective block consisting of courses from several professional fields. New students are admitted for fall or spring semesters. Further details concerning the M.B.A. curriculum may be obtained by contacting the M.B.A. Program Office, College of Business Administration. 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 requirement, 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 totaling more than 25% of the total credit hour requirement shown on the individual proposed degree program be used.

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 oral or written 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 Graduate College 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 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.

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 Computer Science — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual 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.**

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 Graduate College 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 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.

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 Education — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual 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.**

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 Graduate College 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 Education 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 the Graduate College 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 minimum of 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).

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 Engineering — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual 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.**

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 Graduate College 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 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.

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 Landscape Architecture — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual 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.**

The announcement for the final examination must be submitted to the Graduate College 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 program.

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.

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 Public Administration — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual 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.**

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 Graduate College 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.

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 Urban Planning — nor any combination of 684, 685, 690 and 695 totaling in excess of 25% of the total credit hour requirement shown on the individual degree program.

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 Graduate College 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 GRADUATE COLLEGE IN FULFILLING REQUIREMENTS FOR THE MASTER'S DEGREE

Dean — Dean of Graduate College
D. A. & R. — Dean of Admissions and Records
DH — Department Head
GA — Graduate Advisor
ADCom — Advisory Committee

Procedure	Initiate Through / Approved By	Time
1. Apply for admission	D.A. & R. / DH & Dean	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 program	GA & DH / ADCom, DH & Dean	Before second semester registration
5. If thesis is required, submit thesis proposal	ADCom / DH & Dean	14 weeks prior to graduation
6. Apply for degree	Dean	See deadline in "Graduate College 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	ADCom / Dean	By deadline date in "Graduate College Calendar"
9. Submit 3 approved final copies of thesis	ADCom & DH / Dean	By deadline date in "Graduate College Calendar"
10. File letter-of-intent to continue for doctorate, if the student so plans	DH / Dean & D. A. & R.	Immediately upon completion of all requirements for master's degree
11. Arrange for cap and gown		Texas A&M Book Store in the University Center

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 11-week summer session.

To satisfy the continuous residence requirement, the student must complete a minimum of nine credit hours per semester or 11-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.

Credit for Work *in Absentia*

Upon recommendation of the Advisory Committee and approval of the Dean of the Graduate College, a student may be permitted to carry on work in connection with the dissertation *in absentia*. For details concerning *in absentia* registration, see section entitled "Registration."

Time Limit

No student will be granted a doctoral degree from Texas A&M University unless all requirements for the degree are completed within a period of ten consecutive calendar years. Graduate credit for any course work which is 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 Graduate College 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 the Graduate College and enrolling for graduate studies, 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 will be appointed to the student's Advisory Committee by the Dean of the Graduate College at the time of approval of the student's degree program.

The chair, in consultation with the student, will select the remainder of the Advisory Committee. No individual located away from the campus of Texas A&M University 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 at College Station.

The committee members' signatures on the approved degree program 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 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 program, 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 are responsible for counseling the student on academic matters, and, in the case of academic deficiency, initiating recommendations to the Dean of the Graduate College.

Degree Program

The student's Advisory Committee will evaluate the student's previous training and degree objectives. The committee will then outline a proposed degree program 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 program must be submitted to the Graduate College prior to the third semester's registration.** The proposed degree program 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 Dean of the Graduate College. A field of study may be chiefly in one department or may be in a combination of departments. All degree programs must carry a reasonable amount of 691 (Research).

Additional course work may be added to the approved degree program by the student's Advisory Committee if such additional course work 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 approved courses offered by the College of Medicine, the student should see the head of his or her major department, the Dean of the College of Medicine, or the Dean of the Graduate College.

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

Transfer of Credit (See also page 110.)

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 Dean of the Graduate College. 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.

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 or a final examination unless his or her official GPR at the time of the examination is 3.0 or better. This policy applies to any written or oral portions of either of these examinations. The preliminary examination for doctoral students shall be given no later than the end of the first semester after completion of course work and no earlier than a date at which the student is within approximately 6 credit hours of completion of the formal course work on the degree program (i.e., all course work on the degree program 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 Dean of the Graduate College. The written part of the examination will cover each field of study included in the student's program. Each of the student's Advisory Committee members will be responsible for administering a written examination in the member's particular field, **unless the member chooses to waive participation in the written examination.** If the member does choose to waive participation in the written examination, this fact must be indicated on the announcement of the examination. Two or more members of the Advisory Committee may give a joint examination. One or more members may require a student to take a departmental examination to either 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 Dean of the Graduate College.

The schedule for the preliminary examination must be approved by the Dean of the Graduate College. Formal announcement of the preliminary examination must be received in the office of the Dean of the Graduate College 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 Graduate College 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 of Texas A&M University at College Station, Texas.

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 Dean of the Graduate College, 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 **written examinations** (the written portion of the preliminary examination), **all members of the student's Advisory Committee are to be included.** If members of the Advisory Committee choose to waive participation in the written examinations, this fact should be indicated by the inclusion of the word "waived" beside the names of the members concerned. 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. The student has a mastery of the subject matter of all fields in the program.
b. The student has 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 has been taken.

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 examination.

The chair of the student's Advisory Committee will report in writing to the Dean of the Graduate College the results of the preliminary examination. In the report, the Advisory Committee, through the chair, should also make 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 Dean of the Graduate College, a student who has failed the preliminary examination may be given one re-examination, but only after a period of at least six months has elapsed.

A student must be registered in any semester in which he or she asks to appear for either the preliminary or the final examination. Such a student should be registered in the first 5½-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 the doctoral degree, a student must have (1) passed the preliminary examination, (2) filed with the Dean of the Graduate College the dissertation proposal approved by the student's Advisory Committee, and (3) completed the 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 official forms for proposing the dissertation should be completed. The research proposal should be approved at a meeting of the student's Advisory Committee, at which time the committee should carefully review the proposal as to the feasibility of the proposed research and the adequacy of available facilities. The approved proposal, signed by all members of the student's Advisory Committee, including the Graduate Council representative, and the head of the student's major department, should be submitted (in quadruplicate) to the Dean of the Graduate College for final approval. This should be done before commencement of the collection of data.

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 Graduate College. **Instructions as to format should be obtained from the office of the Graduate College.**

By dates announced each semester or summer session in the "Graduate College Calendar," the candidate must submit to the office of the thesis/dissertation clerk of the Graduate College (University Library) three copies of the dissertation in final form. The dissertation must be completed with all suggestions and corrections of the members of the student's Advisory Committee incorporated 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 the Graduate College not 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.

Final Examination

The candidate for the doctoral degree must pass a final examination by deadline dates announced in the "Graduate College Calendar" each semester or summer session. No student may be given a final examination unless his or her official GPR at the time of the examination **is 3.0 or better; furthermore, there must be no unabsolved grades of D, F, or U (unsatisfactory) for any course listed for degree credit on the student's degree program.** To absolve a deficient grade, a student must repeat the course and achieve a grade of C or above. A student must have completed all course work on his or her degree program with the exception of any remaining 691 (Research) or 692 (Professional Study) hours (for which the student must be registered or must have received permission from the Graduate College to delete from his or her degree program), must have an approved research proposal on file with the Graduate College, and must be advanced to candidacy before he or she is eligible to take the final examination. The announcement of the final examination should be submitted to the Graduate College at least two weeks in advance of the scheduled date for the final examination. 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 to the student's Advisory Committee (including the Representative of the Graduate Council (G.C.R.)) in substantially final form and all members of the Advisory Committee 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 to the Dean of the Graduate College 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 in which they plan to graduate, 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 of Texas A&M University at College Station, Texas.

THE DEGREE OF DOCTOR OF EDUCATION

The Doctor of Education (Ed.D.) degree at Texas A&M University 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 Program

Each student's proposed degree program 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. Every program will contain a minimum of 64 semester hours, including the following components:

1. at least six one-hour proseminars stressing the foundation concepts with which every Ed.D. student should be familiar;
2. a core of courses associated with the field of specialization;
3. a set of courses selected to prepare the candidate for a specific professional role;
4. one or more courses that develop basic understanding of the procedures and applications of research;
5. at least one supporting field of 12 or more semester hours or two supporting fields of nine or more semester hours each;
6. a professional internship of at least six semester hours related to the professional role to which the student aspires;
7. 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 1/2-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 of the Graduate College concerning the preparation of proposals, theses, dissertations and records of study. 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 Commettee will report in writing to the Dean of the Graduate College the results of the qualifying examination. The chair of the student's Advisory Committee will report in writing to the Dean of the Graduate College 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 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 Graduate College.

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 Graduate College.

Additional information can be obtained from the Graduate College, 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 Graduate College 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, and be interviewed by the admissions subcommittee of the Doctor of Engineering Program Committee.

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

Residency

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 11-week summer semesters, or a regular semester and an 11-week summer semester. To satisfy the residence requirement, the student must complete a minimum of nine credit hours per semester or 11-week summer semester for the required period.

Student's Advisory Committee

After receiving admission to the Graduate College 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 then 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 then personally interview each prospective committee member to determine whether the prospective member 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 are responsible for counseling the student on academic matters, and, in the case of academic deficiency, initiating recommendations to the Deans of the Graduate College and the College of Engineering.

Degree Program

The student's Advisory Committee will evaluate the student's previous education and career objectives. The committee will then outline a proposed degree program which will constitute the basic academic requirements for the degree. The student's proposed degree program must be submitted to the Graduate College prior to the third semester's registration. 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 Dean of the Graduate College. 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 Dean of the Graduate College will appoint a representative of the Graduate Council to the student's Advisory Committee.

The graduate portion of the proposed degree program 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 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 to the approved proposed degree program 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 Dean of the Graduate College, retake the examination once. The second examination will be administered after a suitable period of preparation, normally not less than 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 an oral examination not less than two weeks before the date on which the degree is to be conferred. 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 Dean of the Graduate College 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. 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 Graduate College.

An internship report 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 internship report 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 internship report must be the original work of the candidate.

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

The Doctor of Environmental Design (D.E.D.) program is intended to provide the candidate with academic and research competence of the highest order in the professions of architecture and landscape architecture.

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 program.

Admission

In addition to the normal admission requirements of the Graduate College, each applicant for admission to the D.E.D. programs of the Departments of Architecture and 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 $8\frac{1}{2}'' \times 11''$.
B. A comprehensive paper describing in detail the individual's goals, objectives, and the proposed program of study.

Program Requirements

Students entering the D.E.D. program must complete 96 hours of approved graduate 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 Graduate College.

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 GRADUATE COLLEGE IN FULFILLING REQUIREMENTS FOR THE DOCTORAL DEGREE

DH—Department Head
GA—Graduate Advisor
ADCom—Advisory Committee
GCR—Graduate Council Representative
Dean—Dean of Graduate College
D. A. & R.—Dean of Admissions and Records

Procedure	Initiate Through / Approved By	Time
1. Apply for admission	D. A. & R. / DH & Dean	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 program	GA & DH / ADCom, DH & Dean	Before third semester registration
5. Complete course work detailed on proposed degree program		Prior to preliminary examination (See *Catalog* for specific details)
6. Arrange preliminary examination	ADCom / Dean	
7. Submit proposal for dissertation or record of study	ADCom, DH & GCR / Dean	Well in advance of expected graduation date
8. Request ADCom to recommend admission to candidacy; completion of 5, 6, and 7 above required	ADCom / Dean	Well in advance of the date on which the degree is to be conferred
9. Prepare rough draft of dissertation	ADCom	
10. Apply for degree	Dean	During final semester; see "Graduate College Calendar" for deadline
11. Submit announcement for final examination	ADCom / Dean	See "Graduate College Calendar" for deadline
12. Submit 3 approved final copies of dissertation or record of study	ADCom & DH / Dean	See "Graduate College Calendar" for deadline
13. Arrange for cap, gown, and hood		Texas A&M Book Store in the University Center

GRADUATION

Graduate degrees are conferred at the close of each regular semester or summer session. Candidates for advanced degrees who expect to complete their work at the end of a given semester must give written notice to the Dean of the Graduate College to that effect not 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 have the degree conferred.

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 Dean of the Graduate College 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 the Dean of the Graduate College.

FINANCIAL ASSISTANCE

Graduate assistantships, both teaching and nonteaching, which require one-half time service, may be applied for by qualified students. An appointment to the latter is normally for nine months, whereas the appointment to a teaching assistantship may vary from nine to 12 months. Graduate assistantships – research are usually 12 month appointments, although vacancies may be filled for shorter periods.

A course load of nine to 12 credit hours of academic work per semester and four hours per summer term is normally required of graduate assistants.

A limited number of fellowships are available for students with outstanding records. Ordinarily such fellowships require no service except satisfactory academic performance. However, at the discretion of the head of the student's major department, a fellow may be required to spend up to one-fourth time on relevant teaching activities during one semester only (or during one 11-week summer session) during a twelve-month period. Since fellowships normally permit full-time study and research, the holder of such a grant will be expected to register for 12 to 16 credit hours per semester and six hours per 5½-week summer term.

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), 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. 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 a Financial Aid Form (FAF) to the College Scholarship Service prior to April 15 for the fall semester and/or academic year and September 15 for the spring semester. Applications for the Guaranteed Student Loan or the PLUS loan must be submitted to the Student Financial Aid Office by July 15 for the fall semester and/or academic year and November 1 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.

LIBRARY FACILITIES

Sterling C. Evans Library

The University's principal research collections, numbering over 1,400,000 physical volumes and the microtext equivalent of more than 400,000 volumes, are housed in a centrally located facility which provides seating for 4,470 readers.

Construction on a new multi-million dollar library addition was completed in February 1979, and renovation on the older part of the library was completed in August 1979. Since completion of the renovation process, 572 lockers on the third through sixth floors 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 current periodicals 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 500,000 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, reference materials and materials temporarily reserved by instructors for required reading; these 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 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.

A Learning Resources Department (LRD) located on the sixth floor has more than 100 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 Medical Sciences Building, serves the College of Medicine and

Veterinary Medicine as well as other students and faculty of Texas A&M University. The library serves as the administrative component of a five-unit consortium of libraries for the College of Medicine. The Texas A&M University Consortium of Medical Libraries also includes the Learning Resource Unit, College of Medicine, in College Station and the Media Center, the Scott and White Memorial Hospital library and the Olin E. Teague Veterans' Center library, all in Temple, Texas. Resources are shared among the libraries by way of subminute telefacsimile transmission of hard copy.

The Medical Sciences Library's collection numbers in excess of 63,000 volumes of bound journals and books, and the library currently subscribes to approximately 1,900 American and foreign periodicals.

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. The information services of data bases accessible from the National Library of medicine, Lockheed, SDC and BRS are in much demand.

The library is open 99 hours each week, and an open stack arrangement provides easy access to books and journals. Books circulate for two weeks unless temporarily reserved for required reading. Periodicals do not circulate. Coin-operated copy machines are available.

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:

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, Outdoor Recreation and the Arts Committee are examples of some of the 35 programming committees and 13 special projects of the MSC Council. All students are invited to become involved in MSC programs and to use the facilities and services of the MSC.

Students' Legal Department offers legal advice and counseling to all students on a variety of problems including landlord/tenant relations, consumer protection complaints and domestic relations problems (located in 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 (located in Room 102, Military Sciences Building).

Student Counseling Service provides limited duration 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 aptitude tests and interest and personality inventories; an academic, educational, career, and personal growth information library; relaxation 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 the law and judicial decisions, 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 minimal fees for certain workshop and biofeedback materials, no fees are charged for any counseling services. In a crisis/emergency situation, come to the Stu-

dent Counseling Service weekdays from 8 a.m. to 5 p.m. or to the Health Center (use the "Urgent Care" entrance) after 5 p.m. and on weekends (located on the third floor, YMCA Building. Call 845-1651 for study skills, testing, academic and career counseling and 845-4427 for personal and weekday daytime emergency counseling.)

Student Activities assists approximately 515 student organizations 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 handles the Quonset Huts, Hensel Park and All Faiths Chapel facilities (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, 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, as well as X-ray, physical therapy, and diagnostic departments. The medical staff includes not only general practitioners, but also consulting specialists in general practice, surgery, orthopedics, urology, and gynecology.

The University Health Center is closed only during official University holidays; otherwise it operates 24 hours per day. The out-patient clinic is open from 8 a.m. to 4 p.m., Monday through Friday, and 8 a.m. to 12 noon on Saturdays. The Health Center fee entitles the student to clinic visits as needed, most diagnostic examinations, care of illnesses or injuries, ten days of treatment(s) per semester for cases requiring hospitalization at the University. A nominal charge is made for all prescription medications.

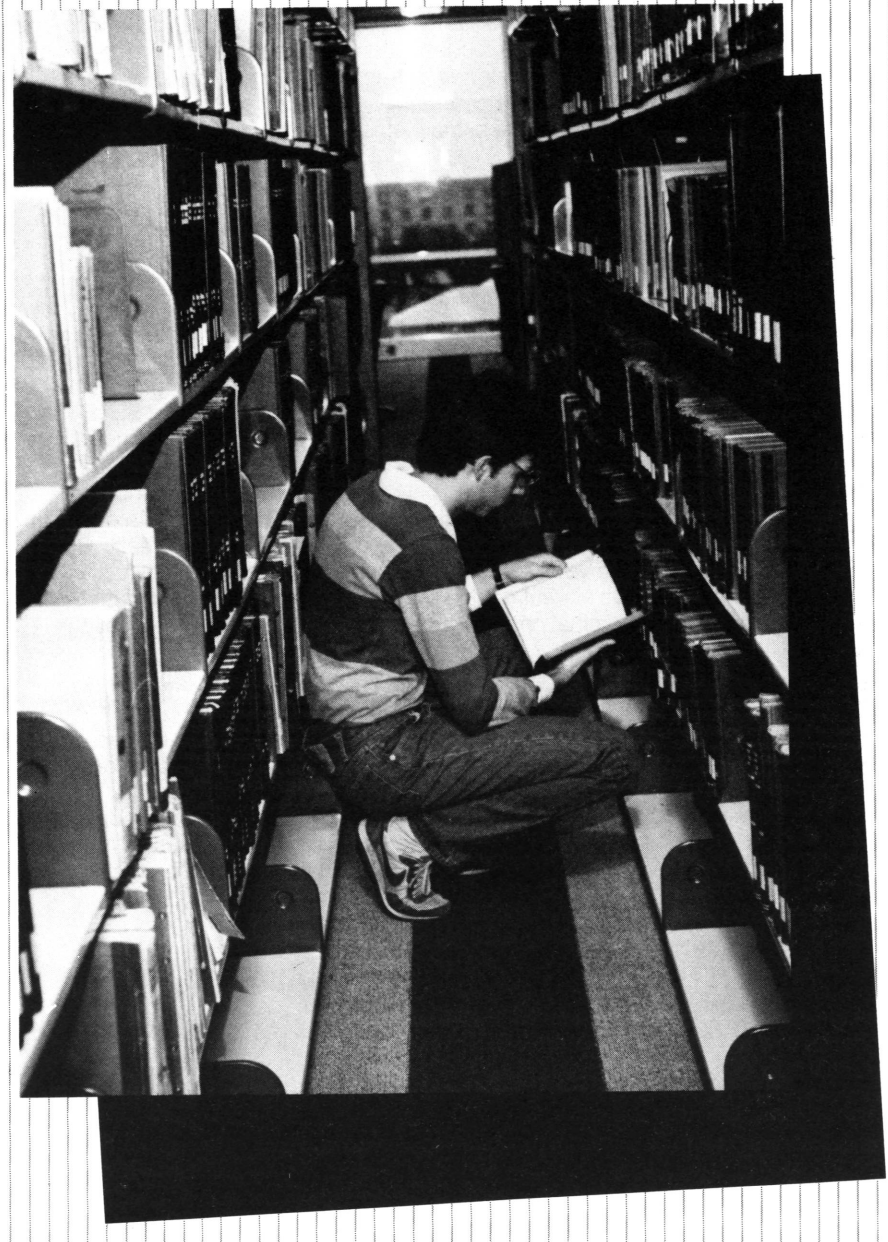
The University Health Center does not perform major surgery. In these cases, the student selects the hospital and surgeon and assumes financial responsibility for surgical or medical procedures. Where appropriate, post-operative care may be provided.

Handicapped and Veterans Coordinator provides assistance to handicapped students and University employees with their special needs. The Coordinator is the veteran's educational certification officer and provides assistance to veterans. 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 146 of the MSC with a full-time counselor to assist eligible handicapped students.

INTRAMURAL-RECREATIONAL SPORTS

Texas A&M is generally recognized as having one of the best all-around intramural and recreational sports programs in the country. Not only does it provide an opportunity for students to participate in a wide variety of sports activities, but it affords a splendid educational opportunity for students to serve as intramural officials and supervisors. Intramural-Recreational Sports 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 sports club program provides students with the opportunity for sports participation on a highly competitive, collegiate level. (Some teams are limited to undergraduate students only.) 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.

TEXAS · A&M



GRADUATE COURSES

All graduate courses offered in the University are described on the following pages and are listed by departments, arranged alphabetically.

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 sixteen 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. G. Apostolou, J. J. Benjamin (Head), E. D. Bennett, L. L. Bravenec, D. L. Crumbley, M. H. El-Badawi, G. A. Giroux, S. D. Grossman, S. H. Kratchman, D. R. Lassila, A. G. Mayper, C. J. Nixon, L. G. Pointer, K. B. Putnam, G. Schugart, W. T. Shearon, Jr., C. D. Stolle**, R. H. Strawser*, E. P. Swanson, M. Tummins, C. E. Wiggins, Jr.

*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.

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.

616. Institutional Accounting. (3-0). Credit 3. Accounting principles and practices of schools, hospitals, governmental agencies and other not-for-profit organizations. Prerequisite: Graduate classification.

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. 611.

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.

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.

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. 607 and B.Ana. 617.

649. Managerial Accounting. (3-0). Credit 3. Cost accounting concepts and use of accounting data in planning and control of operations. 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.

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. 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.

DEPARTMENT OF AEROSPACE ENGINEERING

D. H. Allen, L. A. Carlson, H. L. Chevalier, W. E. Haisler (Interim Head), V. K. Kinra, K. D. Korkan*, S. H. Lowy, J. M. Macha, S. J. Miley, D. J. Norton, C. Ostowari, R. A. Schapery, R. E. Thomas, E. von Lavante, 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, flight mechanics, solid mechanics, propulsion and environmental aerodynamics.

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 the Amdahl 470V/6 and 470V/8 and Cyber 815 digital computers and supporting departmental computational facilities as well as off-campus CDC and Cray computers.

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.

608. Aircraft Flutter Analysis. (4-0). Credit 4. Theoretical development of the structural and aerodynamic equations for two and three-dimensional flutter. Numerical solutions in practical problems to determine flutter velocities. Methods of testing to determine vibration characteristics of aircraft. Prerequisite: Aero. 420 or M.E. 459 or 617.

615. Numerical Methods for Internal Flow. (3-0). Credit 3. Methods for solving internal flow problems; viscous and inviscid compressible flow, special emphasis to correct boundary conditions for transonic cases. 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.

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.

650. Environmental Aerodynamics. (2-3). Credit 3. Natural aerodynamics applied to practical problems. Effects of the Earth's boundary layer on transport processes in urban and rural environments. Wind loads on structures, separated flow regions and interaction between buildings. Laboratory simulation methods. Prerequisite: Undergraduate fluid mechanics.

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.

666. Dynamics of Separation and Turbulent Jet Mixing. (3-0). Credit 3. Turbulent compressible jet mixing; separation and reattachment phenomena; base pressure treatment; dissipation; shock-boundary layer interactions; heat transfer in separated flows. Prerequisite: Aero. 601 or M.E. 622 or approval of instructor.

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.

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.

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 M.M. 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.
632. Structural Stability. (3-0). Credit 3.
633. Theory of Plates and Shells. (3-0). Credit 3.
641. Plasticity Theory. (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 M.M. courses are part of the curriculum in aerospace engineering but are normally taught by faculty of other engineering departments.

603. Foundations of Solid Mechanics. (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.
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.
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

D. A. Bessler, W. E. Black, R. E. Branson, J. R. Conner, E. E. Davis, R. A. Dietrich, R. A. Edwards, D. E. Farris, R. L. Floyd, S. W. Fuller, H. L. Goodwin, Jr., W. R. Grant, R. C. Griffin, W. L. Griffin, W. L. Harman, W. A. Hayenga, J. A. Hopkin, L. L. Jones, R. D. Kay, R. D. Knutson, R. D. Lacewell, C. F. Lard, D. J. Leatham, K. K. Litzenberg, J. M. McGrann, J. R. Martin, J. P. Nichols, D. I. Padberg (Head), J. B. Penson, Jr., J. W. Richardson, M. E. Rister, I. W. Schmedemann, V. E. Schneider, R. B. Schwart, Jr., C. E. Shafer*, C. R. Shumway, T. L. Sporleder, F. E. Stegelin, J. R. Stoll, H. Talpaz, E. Uvacek, Jr., M. K. Wohlgenant, M. D. Woods, A. L. Wright

*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 holding 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.

(Ag.Ec.)

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: Ag.Ec. 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: Ag.Ec. 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 R.S. 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. Economics of Environmental Issues Relating to Agriculture. (3-0). Credit 3. Current and emerging problems in environmental economics relating to agriculture; factors contributing to environmental quality decline. Environmental quality in relation to current agricultural technology, economic problems, legal and political constraints, and institutions. Prerequisite: Math. 130 or equivalent.

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. Development of policies and programs, identifying relevant issues, alternative means to attain desired goals and review of criteria for evaluating action programs.

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 food and fiber products. Causes, effects and relationship 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: Ag.Ec. 630, 611, 641, Stat. 608 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: Ag.Ec. 447 and Stat. 608 or equivalent.

629. Public Administration in Agriculture. (3-0). Credit 3. Basic theories in public administration in agriculture; techniques for accomplishing public goals; legal basis for public agriculture programs; economic, social, political and organizational considerations in agriculture programs.

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, Ag.Ec. 611 or Econ. 630; Ecmt. 663 or Stat. 608.

633. Economics of Underdeveloped Agricultural Areas. (3-0). Credit 3. Function of agriculture in economic growth. Agricultural productivity as influenced by an economy's physical, cultural and institutional attributes. Economic problems of underdeveloped areas.

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. (2-2). 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. Modeling of systems analysis applied to agricultural economics systems. Modeling and simulating of agricultural production and market systems under dynamic deterministic, and stochastic conditions. Simulation carried out using CSMP (Continuous System Modeling Program) computer language. Prerequisite: Ag.Ec. 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. 663.

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: Ag.Ec. 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, discussions with visiting agricultural economists. Prerequisite: Graduate classification.

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* (Interim Head), J. E. Christiansen*, K. L. Denmark, D. R. Herring*, R. A. Lewis, D. C. Pfannstiel

*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.

(Ag.Ed.)

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 vocational agriculture 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 farming, 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 programs. 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. 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.

680. Proseminar. (1-0). Credit 1. Structured seminar in agricultural education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Designed for Ed.D. students with non-agricultural education backgrounds. May be repeated for credit. Prerequisite: Approval of department head.

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, vocational agriculture 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 farming, work experience, extension education, 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, G. F. Arkin, L. F. Bouse, C. G. Coble, G. L. Curry, C. L. Darcey, C. R. Engler, J. L. Goodenough, E. A. Hiler* (Head), O. R. Kunze*, W. A. LePori*, W. M. Lyle, A. R. McFarland, M. J. McFarland, J. L. Nieber, C. B. Parnell, D. L. Reddell*, J. K. Schueller, S. W. Searcy, B. A. Stout, D. A. Suter, V. E. Sweat, J. M. Sweeten, L. H. Wilkes, J. A. Witz, 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, 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.

(Ag.En.)

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.

606. Agricultural Process Engineering. (3-0). Credit 3. Engineering principles involved in mechanical handling, conditioning and storage of agricultural products. Application of refrigeration, electric energy and physical properties of agricultural products. 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 Ag.En. 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: Ag.En. 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: Ag.En. 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: Ag.En. 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: Ag. En. 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.

617. Energy for and from Agriculture. (2-2). Credit 3. Energy use and management in production agriculture; O/I ratios; energy use efficiency, conservation; renewable resource alternatives to fossil energy including biomass fuels such as ethanol, vegetable oil, methane and producer gas; solar heating and wind power. Prerequisite: Approval of the instructor.

619. Workshop in Mechanized Agriculture. (2-2). Credit 3. Offered three or six weeks for technical study and practice of selected subject areas in the field of mechanized agriculture. If offered in three weeks, 12 hours of theory and 12 hours of practice are required per week; or if offered in six weeks, six hours of theory and six hours of practice per week are required. Prerequisite: Professional experience or approval of department head.

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: F.S.T. 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 B.E. 651 and Ch.E. 651.

652. Enzyme Engineering. (3-0). Credit 3. Application of basic principles of life science and engineering technology; large scale unit operations involved in production, isolation, immobilization, economical use of enzymes and optimization of enzyme reactor systems. Application of enzymes in pharmaceutical, food and fine chemicals industries as well as medical and clinical application. Prerequisite: Approval of instructors. Offered jointly by agricultural engineering and chemical engineering and cross-listed with Ch.E. 652.

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.

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, J. W. Bassett, R. W. Blake, O. D. Butler, Jr., F. M. Byers, M. C. Calhoun, L. M. Canfield-Sander, Z. L. Carpenter, T. C. Cartwright, B. E. Conrad, C. E. Coppock, H. R. Cross, C. W. Dill, R. L. Edwards, W. C. Ellis, G. Finne, D. W. Forrest, T. H. Friend, T. R. Greathouse, L. W. Greene, P. G. Harms, D. B. Herd, J. H. Hesby, D. P. Hutcheson, N. M. Kieffer, G. T. King*, D. A. Knabe, D. C. Kraemer, K. S. Kubena, H. O. Kunkel, W. A. Landmann, A. L. Lawrence, H. Lippke, C. R. Long, C. S. Menzies, F. A. Orts, G. D. Potter, R. D. Randel, K. S. Rhee, R. L. Richter, J. O. Sanders, J. W. Savell, G. T. Schelling, J. M. Shelton, G. C. Smith* (Head), S. B. Smith, E. M. Sudweeks, T. D. Tanksley, Jr., W. B. Thomas, G. B. Thompson, M. Tomaszewski, C. Vanderzant, T. H. Welsh, Jr., G. L. Williams

*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 a meat processing plant 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
(An.Sc.)

601. General Animal Nutrition. (3-0). Credit 3. I Nutritional, metabolic and physiological functions of the whole animal. Prerequisites: An.Sc. 303 and 309 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 knowledge and concepts in anatomy, physiology and microbiology of digestion in herbivorous animals and how such relates to current and future nutrition practice and research with emphasis on ruminants. Prerequisites: An.Sc. 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: An.Sc. 305, 306, 309 and 406 or approval of department head.

606. Advancements in Beef Cattle Production. (3-0). Credit 3. II Continuation of An.Sc. 605 with emphasis on efficiency of growth and development of diverse types of cattle through computer simulation of beef production systems. Prerequisites: An.Sc. 307, 309 and 406 or 408 or approval of department head.

607. Physiology and Biochemistry of Muscle as a Food. (3-0). Credit 3. I 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 F.S.T. 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 emphasized through computer simulated gaming and industry contact. Prerequisite: An.Sc. 406 or 408.

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. 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. Prerequisites: An.Sc. 420; graduate classification.

612. Equine Reproduction. (3-0). Credit 3. 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: An.Sc. 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: Gen. 613; Stat. 608, 619.

617. Experimental Techniques in Meat Science. (1-6). Credit 3. II 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 An.Sc. 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: An.Sc. 305, 306, 414; or approval of department head.

620. Advancements in Sheep and Angora Goat Production. (3-0). Credit 3. II Continuation of An.Sc. 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: An.Sc. 305, 306, 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. Prerequisites: An.Sc. 305 and 306 or P.S. 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: An.Sc. 433, Bich. 410, V.P.P. 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: An.Sc. 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 F.S.T. 647.

650. Issues in Animal Agriculture. (3-0). Credit 3. 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.

657. Food Additives, Ingredients and Regulatory Compliance. (3-0). Credit 3. Identification nomenclature, purpose and function of additives used in meat and non-meat food products. Governmental regulatory agencies, their organization and control over food ingredient labeling; commercial supplies and basic manufacturing operations used in food ingredients. Prerequisite: Approval of instructor. Cross-listed with F.S.T. 657.

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 F.S.T. 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
(D.S.)

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: D.S. 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 F.S.T. 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, D. B. Dickson, D. L. Hamilton, H. J. Shafer, D. G. Steele*, J. R. Steffy, N. D. Thomas, F. H. van Doorninck, Jr., G. H. Weir

*Graduate Advisor

The Department of Anthropology's graduate faculty is concerned with training students for professional research and/or teaching careers in academic institutions, governmental agencies, museums or private industry. The department's well-rounded program in anthropology is particularly noted for its strength and emphasis in the fields of nautical archaeology, archaeological conservation, archaeological palynology, geoarchaeology, ethnobotany, historical archaeology, lithic technology 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 encouraged 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 the Graduate College) 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.

614. Eastern Seafaring. (3-0). Credit 3. Culture history of people and watercraft of China, Southeast Asia and Oceania. Types, characteristics, origins and spread of Chinese junks and Oceanic canoes.

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. (3-0). Credit 3. Cultural history of seafaring in the Islamic world, Mediterranean region and northern Europe during medieval and early modern times. Types of ships and boats, sea law, naval tactics, harborworks, routes, cargoes and economics of trade.

620. Texas Prehistory. (3-0). Credit 3. Archaeological evidence for Texas prehistory is traced from the period of earliest occupation to the time of Spanish contact.

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.

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.

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. (2-6). Credit 4. 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. 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.

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

DEPARTMENT OF ARCHITECTURE

L. L. Boyer, C. D. Claycamp, L. O. Degelman*, J. de Jong, D. C. Ekroth, J. O. Greer, W. W. Harper, R. C. Hill, C. M. Hix, Jr., D. F. MacGilvray, G. J. Mann, J. H. Marsh III, J. L. Mashburn, V. L. Paul, D. Poniz, R. D. Reed, E. J. Romieniec, F. J. Trost, R. E. Vrooman, W. V. Wells, W. V. Wendler, D. G. Woodcock* (Head)

*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 and the master of architecture as a post-professional degree. 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, and urban design. The department also provides course work and advisory support for students undertaking doctoral studies in architecture.

(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.

613. Urban Design I. (2-4). Credit 3. State of the art of urban design, the theory and application of the design process to problems of urban context, complexity and scale. Visual, physical and social components of urban design and implementation techniques. Prerequisite: Graduate classification. Cross-listed with Land. 613.

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 C.S. 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: B.C. 336.

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.

641. History of the Urban Environment. (3-0). Credit 3. Evolution of town planning and urban design from prehistory to present. Cultural and industrial conditions affecting development; the American city. 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.

651. Construction Management. (3-0). Credit 3. Organization of construction activities and resources; interrelationship of time, sequence, material delivery and personnel availability. Methods of construction, project planning, management, cost and time accounting. Prerequisite: Graduate classification.

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. Interior architect's role as consultant. Projects require collaboration in team projects and, with other design professionals, to simulate professional practice situation. Prerequisite: Arch. 665 or equivalent.

667. Development Feasibility and Design. (3-9). Credit 6. Selected residential and nonresidential development projects of varying size analyzed by student teams with respect to economic feasibility and cash flow; site analysis; and design concept. Prerequisite: Approval of instructor. Cross-listed with Land. 667 and Plan. 667.

670. Architecture for Health Care Facilities. (3-0). Credit 3. The health care facility as related to medical care organization and the health care delivery system. Prerequisite: Approval of instructor.

671. Health Facility Programming and Design. (3-0). Credit 3. Designed to give architects and planners the insight, background and technical knowledge for rational decision-making in health facilities programming and design. Emerging concepts and developmental systems in problem solution and review of research findings. Prerequisite: Approval of instructor.

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. 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.

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

692. Professional Study. Credit 1 or more each semester. Approved professional study or project undertaken as the terminal requirement for the master of architecture or doctor of environmental design degrees. Preparation of a record of study (required for D.E.D. degree only) summarizing the rationale, procedure and results of the completed project. Prerequisite: Approval of committee chairman.

DEPARTMENT OF BIOCHEMISTRY AND BIOPHYSICS

E. Ashworth-Tsutsui, T. O. Baldwin*, G. W. Bates, C. R. Benedict, E. A. Funkhouser, A. S. Garay, J. M. Gunn, E. D. Harris, G. M. Ihler, H. O. Kunkel, T. M. Lohman, J. M. Magill, E. F. Meyer, J. E. Mullet, J. Nagyvary, J. L. Nordstrom, C. N. Pace, W. D. Park, D. O. Peterson, D. W. Pettigrew, J. M. Prescott, E. G. Sander (Head), A. I. Scott, J. R. Wild, R. D. Wood

*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 stop-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 electrophetic instruments; modern high pressure liquid chromatography equipment; a large scale bacterial fermentation facility; and fully equipped tissue culture laboratories including a P-3 facility, laminar-flow hoods, CO_2-incubators, etc.

Research activities in the department involve plants, animals, and microorganisms and span the broad fields of molecular biology, proteins, lipids, nucleic acids, intermediary metabolism, biochemical nutrition, and molecular biology. More specifically, current

research interests include enzymology and enzyme mechanisms, conformational stability of proteins; structure-function relationships in proteins; analysis of active sites by computer graphics; mechanisms of protein turnover and regulation of intracellular protein degradation; lipid chemistry and metabolism; structural analysis of membrane lipids; effect of normal and abnormal dietary fatty acids on composition and biosynthesis of lipids; control of serum cholesterol; biochemistry of polypeptide hormones, their physical, chemical and biological properties, and mechanism of action; the absorption, deposition, mobilization and regulation of trace mineral metabolism; evaluation of novel protein food sources; biochemical control mechanisms regulating intermediary metabolism; and nucleotide chemistry, RNA processing, protein-nucleic acid interactions and transcriptional regulation of gene expression.

Students entering graduate work in biochemistry or biophysics are required to have adequate preparation in chemistry, mathematics, physics and modern 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 substances found in living matter. Proteins, enzymes, carbohydrates and carbohydrate metabolism. Prerequisites: Chem. 228, 316.

604. General Biochemistry II. (3-0). Credit 3. Continuation of Bich. 603. Cell respiration. Photosynthesis. The biochemical properties of lipids and nucleic acids. Lipid and nitrogen metabolism. Principles of gene action. Prerequisite: Bich. 603.

605. Biochemical Calculations and Their Applications. (1-2). Credit 2. Development of data handling skills. Laboratory exercises, demonstrations and calculation exercises. Interpretation of biochemical data. Prerequisite: Graduate classification.

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.

618. Chemistry and Metabolism of Lipids. (3-0). Credit 3. Lipids of biological membranes and lipoproteins. Intermediary metabolism of glycerolipids, glycolipids and steroids and its regulation. Lipidoses. Prerequisite: Bich. 604.

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. 604 and Gen. 431. Cross-listed with Gen. 631.

636. Metals in Biological Systems. (3-0). Credit 3. Roles of metals in life processes. Exact molecular structure and function; metals as integral part of many biomolecules and subcellular organelles and the metabolic processes mediated. Medical aspects. Prerequisite: Bich. 411 or 603.

641. Nutritional Mechanisms and Metabolic Regulation in Man. (3-0). Credit 3. Mechanisms of nutrient digestion, absorption, transport, degradation and intracellular metabolic regulation at the molecular level. Mechanisms in the normal and the diseased state. Prerequisites: 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.

650. Chemistry and Metabolism of Nucleic Acids. (3-0). Credit 3. Chemical, physical and biological characteristics of nucleic acids. 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 Gen. 631 for full description of related course.

BIOPHYSICS
(Biph.)

626. Radioisotopes Techniques. (2-3). Credit 3. Nature and use of radioisotopes in chemical and biophysical studies. History, general properties of nuclei, nuclear reactions, radiation, health physics and instrumentation. Prerequisites: Math. 122; Phys. 201, 202.

685. Problems. Credit 1 or more each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisites: Approval of instructor prior to registration; graduate classification.

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

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

BIOENGINEERING
(See Industrial Engineering)

BIOPHYSICS
(See Biochemistry and Biophysics)

DEPARTMENT OF BIOLOGY

S. K. Alexander, K. J. Aufderheide, G. Bhaskaran, V. M. Bryant, Jr., R. C. Burghardt, M. E. Christensen, E. R. Cox, K. H. Dahm, N. O. Dronen, W. P. Fife, B. G. Foster*, I. F. Greenbaum, T. C. Hall (Head), D. E. Harper, J. E. Kanz, W. M. Kemp, M. L. Lamoreux, D. R. Lueking, D. S. MacKenzie, D. M. J. Mueller, C. L. Nessler, D. W. Owens, E. T. Park, C. O. Patterson, J. C. Pommerville, S. M. Ray, W. L. Rickoll, P. J. Rizzo, H. W. Sauer, G. L. Schroeter, M. H. Sweet, W. A. Taber, T. L. Thomas, C. Vanderzant, M. K. Wicksten, H. D. Wilson

*Graduate Advisor

The graduate faculty of the Department of Biology is concerned with training students for professional research and/or teaching careers in academic institutions, government agencies, or industry. The department's areas of strength are developmental, cellular and molecular biology, microbiology and immunology, botany, and ecology and evolutionary biology (including marine biology).

The Department of Biology is located in a modern biological sciences complex consisting of three buildings covering over 200,000 square feet of floor space. Fully-equipped laboratories containing a great variety of modern equipment are available for graduate research. The Electron Microscopy Center, housed in the Biological Sciences Building, contain sophisticated instrumentation also available for graduate student research. The biology complex is centrally located on campus next to the main library, providing easy access to most of the campus facilities. The department can use the central Computing Services Center, which has an Amdahl 470 computer system.

Degree programs can be chosen in biology, microbiology, botany or zoology. The degree plan is selected by the individual student with the assistance of a faculty advisor and advisory committee; the course work is kept flexible, within the guidelines of the Graduate College, to allow students to pursue their individual professional goals. Graduate students are expected to gain teaching experience as assistants in laboratory courses.

Completion of the Ph.D. program, which consists of formal courses and emphasizes independent research resulting in a dissertation, usually takes four years. The dissertation is expected to represent an original significant contribution to science. Doctoral students are required to demonstrate competence in several areas of biology on a preliminary examination administered by the advisory committee and to defend their dissertation research before the committee and other interested persons. M.S. programs, in which there are both thesis and nonthesis options, take about two years to complete. The nonthesis option is available for those individuals who do not desire a career in research.

The Department of Biology also encourages cooperative programs. Many scientists located in the Departments of Biochemistry and Biophysics, Plant Sciences, Animal Sciences, Geography, Wildlife and Fisheries Sciences, Entomology, and Oceanography interact with members of the Department of Biology. These departments offer courses which are available to our students and faculty members from these departments often serve on the Advisory Committees for graduate students in biology. Graduate studies in marine biology can also be performed at the Galveston campus of Texas A&M University.

The current research interests of the thirty-six members of the graduate faculty in biology include marine and estuarine ecology; intracellular development and differentiation in the ciliate protozoa; developmental biology of insects; palynology and paleoethnobotany; the role of intercellular communication in ovarian physiology; developmental biology, utilizing the slime mold *Physarum polycephalum* as a model system; phycology, emphasizing the dinoflagellates; parasite ecology and genetics; hyperbaric physiology and medicine; cell mediated immunity to infectious diseases; vertebrate cytogenetics and cytosystematics; ecology of intertidal and subtidal benthic invertebrate communities; biochemical parameters governing the interaction of proteins with nucleic acid polymers; neurophysiology and animal behavior; parasite immunology; freshwater ecology; mode and regulation of intracytoplasmic membrane assembly in the non-sulfur purple photosynthetic bacteria; bryology; developmental plant anatomy and morphology; behavior and comparative endocrinology of marine and aquatic vertebrates; systematics, biogeography and ecology of marine planktonic copepod crustaceans; physiology and biochemistry of microalgae, especially photobiology and energy metabolism of blue-greens; structure, function and evolution of the eukaryotic chromatin fiber, with emphasis on the histone and non-histone chromosomal proteins of the algae; cytogenetics of Orthroptera; ecology, ethology, evolution and biogeography, especially with hemipteran insects; primary and secondary shunt mechanisms of fungi and bacteria; and vascular plant systematics and evolution with emphasis on the origin and systematic relationships of domesticated plants.

Further information may be obtained from the Department of Biology graduate advisor.

(Biol.)

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.

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.

607. Ethnobotany. (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.

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: Biol. 408 or approval of instructor.

610. Immunology. (3-4). Credit 4. Immunological reactions as related to the diagnosis of human disease. Both basic immune phenomena and practical laboratory experience. Prerequisite: Biol. 351 or equivalent.

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.

612. Biology of Estuarine Organisms. (3-3). Credit 4. Experimental study of biological adaptations and ecological interrelationships of estuarine organisms. Prerequisite: Course in physiology or approval of instructor.

613. The Sensory Physiology of Fish Behavior. (3-0). Credit 3. Role of sensory processes and perception in animal behavior; orientation mechanisms in marine and freshwater fish and other aquatic organisms. Prerequisite: Major in biology, wildlife and fisheries sciences or psychology or approval of instructor.

614. 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. Prerequisite: Graduate classification in a biological or related science.

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. Prerequisite: Graduate classification in biology or related science.

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, Biol. 605 or W.F.S. 601, Gen. 603 or equivalent.

617. Biology of Cells. (4-0). Credit 4. 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 in a biological or related science.

619. Plant Biosystematics. (3-3). Credit 4. Experimental and analytical approaches to plant variation and evolution; breeding systems, cytogenetics, hybridization and phylogeny. Prerequisite: Biol. 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: Biol. 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: Biol. 327 or equivalent.

625. Bryology. (3-3). Credit 4. Morphology, systematics and ecology; field studies of mosses, liverworts and hornworts. Offered in alternate years. Prerequisite: Approval of instructor.

627. Helminthology. (3-3). Credit 4. Parasitic worms, especially Trematoda, Cestoda, Nematoda and Acanthocephala. Prerequisite: Biol. 436 or approval of instructor.

628. Scanning Electron Microscopy. (3-6). Credit 5. Principles and techniques of scanning electron microscopy. Prerequisite: Approval of instructor one month prior to registration.

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. Physiology of Microorganisms. (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.

637. Marine Botany. (2-6). Credit 4. Systematics, morphology, ecology and economics of marine macroalgae, microalgae and sea grasses. Gulf of Mexico and especially the Texas coast. Both laboratory and field work required. Prerequisite: Graduate classification in biology or related science.

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: Biol. 434 or approval of instructor.

647. Methods in 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 oil isolates for capacity to degrade radioactively-labeled molecules and to produce antibiotics. BOD and bacterial analyses of wastewaters. Prerequisite: Bich. 410 or 412.

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. Prerequisites: Course in physiology, Bich. 410 or equivalent or approval of instructor.

651. Mycology. (2-6). Credit 4. Fungi; life cycles of representative forms; genetics and cytology; taxonomy; ecology. Prerequisite: Biol. 353 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 exercise or man-made environment. Classroom demonstrations. Prerequisite: Biol. 220 or 388 or 470 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.

657. Ecology of Host-Parasite Populations. (3-3). Credit 4. Host-parasite population dynamics; impact of environmental factors on parasite populations and the parasite's impact on the ecosystem. Prerequisite: Approval of instructor.

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 is unnecessary.

662. Biology of the Mollusca. (3-3). Credit 4. Survey of the phylum mollusca. Prerequisite: Graduate classification in biology or related fields 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. Prerequisites: Biol. 435 or equivalent; graduate classification 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: Biol. 435 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.

667. Physiology of Host-Parasite Systems. (3-0). Credit 3. Physiology and biochemistry of parasites, environmental conditions under which parasites are living and integration of the host into functional host-parasite complex. Prerequisite: Courses in physiology or biochemistry and immunology or approval of instructor.

668. Biology of Animal Symbioses. (3-0). Credit 3. Physiology, ecological relations and populations significance of various types of symbiotic associations; parasitism and mutualism. Prerequisite: Biol. 667 or approval of instructor.

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; pattern formation; hormones in development. 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. Prerequisite: Graduate classification in appropriate field.

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. May be repeated once for credit.

690. Theory of Biological Research. (3-0). Credit 3. Design of research experiments in various subfields of biology 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. Prerequisite: Approval of ranking professor in field chosen.

BUSINESS ADMINISTRATION
(B.A.)

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.

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*, F. P. Buffa, J. J. Dinkel, G. C. Fowler**, W. L. Fuerst, N. Gaither, L. W. Glorfeld, J. J. Kanet, R. G. McLeod, Jr., J. R. Mote, D. L. Olson, W. Rose, W. Stein, M. J. Tretter, E. M. White, 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, operations and logistics management, and quantitative analysis.

The M.B.A. degree program consists of 48 credit hours of which 12 credit hours may be taken in the department. Areas of course work include business computing science, operations and logistics 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, operations and logistics 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 has a systems point of view stressing computers and quantitative anslysis and systems analysis.

The typical Ph.D. program is comprised of a set of core courses covering computer programming, systems analysis, quantitative methods, management information systems, and research methodology. In addition, the student will select an area of specialization for in-depth study from among MIS, Management Science, or Operation and Logistics Management.

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

(B.Ana.)

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: B.Ana. 617 or equivalent.

617. Automated Business Systems. (2-0). Credit 2. Business data processing; concepts of why and how the business community uses computing techniques. Selected business applications.

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: B.Ana. 337 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: B.Ana. 617 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: B.Ana. 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: B.Ana. 618 or equivalent.

632. Mini/Micro Business Systems. (3-0). Credit 3. Theory and application of mini/microcomputer systems to business-related data processing needs. Prerequisites: B.Ana. 620 and at least concurrent enrollment in B.Ana. 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: B.Ana. 666.

646. Business Trends, Fluctuation, and Measurements. (2-0). Credit 2. Business trends and economic fluctuations; theory, causes and control of cyclical behavior; analytical forecasting. Basic business statistical techniques and applications. Prerequisite: Math. 230 or equivalent or approval of instructor.

656. Operations Management. (2-0). Credit 2. Theory and applications of designing, analyzing and controlling productive systems in the allocation and use of productive resources to produce goods and services. Prerequisites: B.Ana. 646 and 666 or equivalents; graduate classification in business administration.

666. Quantitative Analysis for Business Decisions. (2-0). Credit 2. Formulation and structuring of business problems using selected quantitative techniques. Investigation of prior research and formulation of specific problems. Prerequisite: B.Ana. 646 or equivalent or approval of instructor.

668. Business Computer Models and Simulation. (3-0). Credit 3. Design and implementation of computerized decision models in the business organizational setting. Prerequisites: A computer language; B.Ana. 666.

670. Distribution Management (3-0). Credit 3. Management of physical distribution systems, the activities of planning, implementing and controlling flows of materials from supplier through production or operations to consumer. Economic trade-offs involved in decisions regarding the transportation and storage of materials and the counterflow of information. Prerequisite: Approval of instructor.

671. Distribution Analysis. (3-0). Credit 3. Integration of physical distribution decisions to facilitate product and information flows. Development of analytical skills and the application of quantitative techniques for planning and controlling physical distribution operations. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1 each semester. Critical examination of subject matter presented in current periodicals, recent monographs and bulletins in field of quantitative methods applied to business.

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 3 each semester. Directed study on 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 business analysis; evaluation of current research and controversial issues in quantitative methods, business data processing and physical distribution management. For doctoral students only. 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: Graduate classification in business analysis.

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

DEPARTMENT OF CHEMICAL ENGINEERING

A. Akgerman*, R. G. Anthony, D. B. Bukur, J. A. Bullin, R. Darby, R. R. Davison, L. D. Durbin, P. T. Eubank, A. M. Gadalla*, C. J. Glover, K. R. Hall, D. T. Hanson, W. B. Harris, C. D. Holland (Head), J. C. Holste, K. N. Marsh, G. B. Tatterson, 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 seeking a master's 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. A minimum of four chemical engineering courses and one mathematics course form a partial requirement for the M.S. degree, five chemical engineering and one mathematics for the M.Eng. degree and eight chemical engineering and two mathematics for the Ph.D. degree. A three-hour course in technical writing is required for the Ph.D. degree.

Research is an integral part of the work leading to an advanced degree. Some areas of specialization are rheology, thermodynamics, cryogenics, polymer kinetics, distillation, electrochemistry, phase equilibria, extraction, process control, transport phenomena, economics, environmental research, tertiary oil recovery, heat transfer, lignite liquefaction and gasification, catalysis, mixing phenomena, mathematical models, poly-

mer solution thermodynamics, methanol fuel and solar energy. 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 descriptive brochure available by writing to the graduate advisor in the department.

(Ch.E.)

606. Unit Operations. (3-0). Credit 3. Applications of chemical engineering fundamentals in manufacture of chemicals, refining petroleum and other allied industries. Prerequisite: Ch.E. 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: Ch.E. 323.

612. Distillation. (3-0). Credit 3. Process design calculations involving distillation of multicomponent and complex systems. Extractive and azeotropic distillation. Prerequisites: Ch.E. 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: Ch.E. 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; Ch.E. 354.

623. Applications of Thermodynamics to Chemical Engineering. (3-0). Credit 3. Application of thermodynamics to chemical engineering operations and processes. Prerequisite: Ch.E. 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: Ch.E. 464.

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: Ch.E. 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: Ch.E. 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: Ch.E. 623 or Chem. 611.

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.

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: Ch.E. 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 Ag.En. 651 and B.E. 651.

652. Enzyme Engineering. (3-0). Credit 3. Application of basic principles of life science and engineering technology; large scale unit operations involved in production, isolation, immobilization and economical use of enzymes, and optimization of enzyme reactor systems. Application of enzymes in pharmaceutical, food and fine chemicals industries as well as medical and clinical application. Prerequisite: Approval of instructors. Cross-listed with Ag.En. 652.

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. E. Bergbreiter, J. W. Bevan, J. O'M. Bockris, A. Clearfield, D. L. Cocke, D. C. Conway, F. A. Cotton, G. M. Crippen, K. H. Dahm, D. J. Darensbourg, M. Y. Darensbourg, J. P. Fackler, Jr., K. A. Gingerich, M. B. Hall, K. E. Harding, J. F. Haw, E. E. Hazen, Jr.*, R. M. Hedges, C. A. Hoeve, J. L. Hogg, K. J. Irgolic, L. L. Klein, J. Laane, R. R. Lucchese, J. H. Lunsford, R. D. Macfarlane, A. E. Martell, C. R. Martin, E. A. Meyers, J. B. Natowitz (Head), 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, R. P. Schmitt, E. A. Schweikert, A. I. Scott, B. L. Shapiro, F. Sicilio, Y. N. Tang, 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 either two or four 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. Six nuclear-related faculty, including three 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. Highly relevant research problems are available in pollution control and environmental 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 major addition to the Chemistry Building, to be completed in 1986, will bring 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 J. B. Natowitz, 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.

609. Theory of Organic Chemistry. (3-0). Credit 3. Detailed and advanced coverage of the basic principles of physical organic chemistry; applications of molecular orbital theory, solution kinetics and determination of reaction mechanism. Prerequisite: Chem. 646.

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.

617. Applications of Instrumental Methods of Analysis. (0-3). Credit 1. Advanced laboratory problems in instrumental methods of analysis. Prerequisite: Chem. 602 or registration therein 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.

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.

629. Chemistry of the Regular Elements. (3-0). Credit 3. Chemistry of the elements of subgroup A of the periodic table and the noble gases. Prerequisite: Chem. 641.

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.

635. Heterocyclic Compounds. (3-0). Credit 3. Structure, preparation and properties of heterocyclic compounds with special emphasis on those with biological activity. Prerequisite: Chem. 228.

637. Electroanalytical Chemistry. (3-0). Credit 3. Modern electroanalytical methods including potentiostatic, galvanostatic, sweep and periodic techniques. Prerequisite: Chem. 620 or approval of instructor.

638. Chemical Instrumentation. (2-3). Credit 3. The measurement process in chemical experimentation, review of analog and digital electronics, detector mechanisms, signal transfer and enhancement, automated control and computer interfacing techniques. Laboratory work emphasizes electronics and instrument design. Prerequisite: Approval of instructor.

640. Transition Metal Chemistry. (3-0). Credit 3. Chemistry of the subgroup B elements of the periodic table; lanthanides and actinides. Coordination compounds. Prerequisite: Chem. 641.

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. Homogeneous Catalysis. (3-0). Credit 3. Chemistry of metal complexes pertaining to catalysis; homogeneous active sites including chemical kinetics and energetic aspects; elementary processes for general and radical interactions; mechanisms of electron transfer and oxidation-reduction reactions, group transfer reactions, hydrogenations, carbonylation, polymerizations, etc. Prerequisites: Chem. 640, 641, 645.

645. Organometallic Chemistry of Transition Metals. (3-0). Credit 3. Nomenclature, classification, nature of the bond, implications of the significant physical properties, structure, structure determination, reactions and catalysis of organotransition metal compounds. Prerequisites: Chem. 641, 646.

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.

652. Recent Topics in Analytical Chemistry. (2-0). Credit 2. Recent advances and special methods in the field of analytical chemistry. Methods discussed in terms of basic theory, particular advantages, limitations and required instrumentation. Prerequisite: Chem. 620. 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.

654. Recent Topics in Inorganic Chemistry. (2-0). Credit 2. Topics such as boron hydrides, crystal field theory, inorganic reaction mechanisms, organometallic chemistry and nuclear chemistry. Prerequisite: Chem. 641. 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.

657. Magnetic Resonance Spectroscopy. (3-0). Credit 3. Magnetic resonance and electron paramagnetic, nuclear magnetic and nuclear quadrupole magnetic resonance spectroscopies. Application to elucidation of molecular structure. Prerequisites: Chem. 648 and/or approval of instructor.

658. Theoretical Nuclear Chemistry. (3-0). Credit 3. Phenomenology and theory of selected topics in current literature of nuclear chemistry; e.g., collective model, compound nuclear reactions and fission. Prerequisite: Chem. 648 or approval of instructor.

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.

664. Organometallic Chemistry of the Main Group Elements. (3-0). Credit 3. Synthesis, reactivities, structures and applications of organometallic compounds of the main group elements. Correlation between physical and chemical properties of organometallic compounds and position of the central metal atom in the periodic system. Prerequisites: Chem. 641, 646.

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.).

670. Chemistry of Proteins. (3-0). Credit 3. Chemical synthesis and degradation of proteins, chemical modification of proteins, primarily specific reactions with affinity labeling reagents. Applications of chemical modification. Prerequisites: Bich. 603, Chem. 646 or approval of instructor.

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: D. R. Basco, B. Batchelor, W. L. Beason, A. R. Benton, Jr., J.-L. Briaud, C. E. Buth, S. C. Chapra, H. M. Coyle, C. L. Dudek, W. A. Dunlap, J. E. Flipse, B. M. Gallaway, C. P. Giammona, R. W. Hann, 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, A. Laufer, W. B. Ledbetter, D. N. Little, Jr., Y. K. Lou, L. L. Lowery, Jr., R. L. Lytton, D. McDonald (Head), A. R. McFarland, A. H. Magnuson, E. L. Marquis, J. E. Martinez, J. M. Mason, Jr., D. A. Maxwell, C. J. Messer, J. R. Morgan, D. V. Morris, J. M. Niedzwecki, J. K. Nelson, Jr., J. S. Noel, M. P. J. Olsen, R. M. Olson, R. E. Randall, R. O. Reid, T. D. Reynolds, E. J. Rhomberg*, F. L. Roberts, H. E. Ross, Jr., N. J. Rowan, C. H. Samson, Jr., D. Saylak, R. A. Schapery, J. F. Slowey, V. G. Stover, N. D. Stubbs, G. Stukhart, K. A. Tenah, L. J. Thompson, J. T. Tielking, G. Venezian, Y. Weitsman, C. E. Woods, D. L. Woods, R. A. Wurbs

OCEAN ENGINEERING: D. R. Basco*, J. E. Flipse, J. B. Herbich, W. P. James, Y. K. Lou (Program Head), J. M. Niedzwecki, R. E. Randall, R. O. Reid, G. Venezian

*Graduate Advisor

CIVIL ENGINEERING (C.E.)

A variety of courses is offered in civil engineering to permit a student to specialize in a given branch. The department is especially well equipped to offer, with support from other departments, areas of specialization in civil engineering systems; coastal and ocean engineering; construction engineering; cost engineering; environmental engineering; forest engineering (in cooperation with the Departments of Agricultural Engineering and Forest Science); 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.

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: C.E. 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: C.E. 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: C.E. 311.

608. Solid Waste Engineering. (1-6). Credit 3. Design and operation of solid waste collection and disposal systems. Review of appropriate state and federal regulations. Prerequisite: Approval of instructor.

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: C.E. 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: C.E. 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: C.E. 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: C.E. 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: C.E. 457 or equivalent.

618. Traffic Engineering: Operations. (2-3). Credit 3. Advanced theory and application of traffic control. Signalization and freeway operations. Prerequisite: C.E. 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: C.E. 344 or equivalent.

623. Properties of Concrete. (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. Hydrology. (3-0). Credit 3. Weather and hydrology, precipitation, streamflow analysis, evaporation and transpiration, subsurface water, streamflow hydrographs, precipitation-runoff relations, streamflow routing, computer simulation of streamflow, probability studies, stochastic hydrology, sedimentation, morphology of river basins. Prerequisite: Approval of instructor.

628. Hydraulic Engineering. (2-3). Credit 3. Project course in which student teams analyze and solve hydraulic problems. Pipelines, pipe networks, storm-water collection systems, open channel flow, river modification, flood plain delineation, spillway, outlet works, energy dissipators and water hammer. Prerequisite: 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: B.C. 479 or approval of instructor. Cross-listed with B.C. 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 C.E. 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: C.E. 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: C.E. 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. Prerequisites: C.E. 348, 473, 488 or equivalent.

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. Prerequisites: C.E. 348, 473, 490 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. Prerequisites: C.E. 348, 473, 490 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.

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: C.E. 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; C.E. 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: C.E. 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: C.E. 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. Behavior of soils during high rates of loading. Introduction to wave propagation through soils, cratering by explosives, penetration of earth by projectiles, dynamic loads on foundations and slope stability during earthquakes. Prerequisite: Math. 601 or registration therein.

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.

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; M.M. 467, or approval of instructor.

660. Photogrammetry. (3-0). Credit 3. Photographic processes related to measuring, interior and exterior orientation of photographs, analysis of geometry and measurements relating photographic image and object, applications of photogrammetry to science and engineering. Prerequisites: Math. 152; 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 F.S. 661.

664. Water Resources Development. (3-0). Credit 3. Planning and measurement concepts for control, conservation and use for water resources by emphasizing interdisciplinary approaches; alternatives to minimize flood damages; Texas water rights and water districts, multipurpose projects, environmental impacts, policies for the future and systems approach to planning. Prerequisite: Approval of instructor.

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: C.E. 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: C.E. 462 or approval of instructor. Cross-listed with O.E. 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 O.E. 686.

687. Marine Foundation Engineering. (2-2). Credit 3. Foundation engineering problems associated with a marine environment. Settlement and bearing capacity analysis of near-shore and offshore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles and sheet-pile walls. Prerequisites: C.E. 365; approval of instructor. Cross-listed with O.E. 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 M.M. 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
(O.E.)

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.

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: C.E. 311, M.E. 459 or equivalent, or approval of instructor.

640. Deep Ocean Mining of Surficial Deposits. (3-0). Credit 3. Metallogenesis and morphology of deep seabed surficial ore bodies; mining systems, economic incentives, legal and political considerations; protection of the environment. Prerequisite: C.E. 311 or approval of instructor.

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: O.E. 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: O.E. 671.

675. Coastal Engineering I. (3-0). Credit 3. Small amplitude wave theory and applications to engineering problems. Analysis of wave data. Wave forces on coastal structures. Wave run-up on seawalls and breakwaters. Control of oil spills and offshore pipelines. Prerequisite: Approval of instructor.

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 off-shore 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: O.E. 300, 301, or approval of the instructor.

677. Coastal Engineering II. (3-0). Credit 3. Non-linear wave theories and their application to engineering problems; wave forces on off-shore structures; floating, hydraulic and pneumatic breakwaters; off-shore pipelines; diffusion in coastal waters; oil spill containment and collection. Prerequisite: C.E. 675 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: C.E. 462 or approval of instructor. Cross-listed with C.E. 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 C.E. 686.

687. Marine Foundation Engineering. (2-2). Credit 3. Foundation engineering problems associated with a marine environment. Settlement and bearing capacity analysis of near-shore and offshore foundations. Computer programs used to analyze axially-loaded piles, laterally-loaded piles and sheet-pile walls. Prerequisites: C.E. 365; approval of instructor. Cross-listed with C.E. 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 COMMUNICATIONS

D. R. Bowers, M. L. Chastain, D. C. Johnson, C. J. Leabo, B. G. Rogers

JOURNALISM
(Jour.)

601. Mass Communication Processes. (2-3). Credit 3. Intensive training in news writing, photography, television production and typography for mass and specialized media. Typing ability required.

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, etc.; 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. Investigation and analysis of trends and changing role of media with focus upon current and future problems and responses. May be repeated for credit.

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

DEPARTMENT OF COMPUTER SCIENCE

S. B. Childs, D. Colunga, D. D. Drew, D. K. Friesen, W. M. Lively*, B. H. McCormick (Head), S. M. Morgan, U. W. Pooch, S. V. Sheppard, D. B. Simmons, G. N. Williams

*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 specialization in computer science include theoretical computer science, artificial intelligence and cognitive modelling, computer vision, graphics and robotics, computational mathematics, computer systems and networks, software systems science and engineering, 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.

(C.S.)

611. Survey of Programming Languages. (3-0). Credit 3. Techniques for specifying the syntax and semantics of programming languages. Language concepts such as data structuring, information binding, control structures, execution environments and extensibility are examined by studying scientific, data processing, list processing and multi-purpose languages. Programming assignments in the various languages. Prerequisites: C.S. 203, 401, or equivalent.

612. Programming Methodology. (3-0). Credit 3. Methodology and techniques involved in the design, production and maintenance of software systems. Prerequisites: C.S. 203, 401 or equivalent.

613. Computer Software Systems. (3-0). Credit 3. Hardware/software evolution leading to state-of-the-art operating systems. Operating system concepts and system elements as separate entities followed by synthesized examples from the areas of minicomputer and large-scale computer applications. Comparison of major manufacturer's current operating systems. Prerequisite: C.S. 403.

614. Computer Architecture. (3-0). Credit 3. Computer architectures and structures from the classical von Neumann machines to state of the art computer organizations such as array, pipeline and associative processors. Hardware components: instruction set design; memory systems and hierarchies; control units and microprogramming; ALU's; parallelism; lookahead; concurrency; vector computers; stack computers; super computers and direct high level language computers. Prerequisite: C.S. 301.

615. Database Systems. (3-0). Credit 3. Data processing systems; construction and maintenance of file structures for on-line systems, storage allocation and collection, and design and use of generalized data management systems. Prerequisite: C.S. 303.

621. 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 differential equations. Problems in ordinary differential equations. Prerequisites: C.S. 407, 458 or equivalents.

622. Computer Communications and Networks. (3-0). Credit 3. Basic hardware/software for computer communications. Synchronous/asynchronous systems. Computer networks, routing, protocols. Time sharing systems, interface between operating system and network. Common carrier services. Prerequisites: C.S. 613.

623. Software Engineering. (3-0). Credit 3. Application of engineering principles to the design, production and maintenance of software systems. Technical and managerial issues. Prerequisites: C.S. 612, 615.

624. Simulation. (3-0). Credit 3. Introduction to simulation and comparison with other problem-solving techniques. Discrete simulation models and review of queuing theory and stochastic processes. Comparison of discrete change simulation languages. Simulation methodology including generation of random numbers and variates and validation of simulation models and results. Selected applications of simulation. Prerequisites: C.S. 458 or equivalent.

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: C.S. 203, 204.

627. Formal Languages and Automata Theory. (3-0). Credit 3. Semi-formal introduction of computer languages and their relationships to various automata. Regular, context free, context-sensitive grammars and their implementations on finite automata, pushdown automata and Turing machines. Prerequisite: C.S. 611.

628. Compiler Construction. (3-0). Credit 3. Definitions of formal grammars: arithmetic expressions and precedence grammars, context-free and finite-state grammars. Algorithms for syntactic analysis: recognizers, backtracking, operator precedence techniques. Semantics of grammatical constructs: reductive grammars, Floyd productions, simple syntactical compilation. Relationships between formal languages and automata. Prerequisites: C.S. 204, 611.

629. Analysis of Computer Algorithms. (3-0). Credit 3. Methods and techniques of analysis of non-numeric and arithmetic algorithms. Asymptotic time and space behavior of selected algorithms. P and NP problems.

630. Information Storage and Retrieval. (3-0). Credit 3. Structure of semi-formal languages and models for the representation of structured information. Information content by statistical, syntactic and logical methods. Search and matching techniques. Automatic retrieval systems. Question-answering systems. Evaluation of retrieval effectiveness. Prerequisites: C.S. 203, 204, 404.

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.

684. Professional Internship. Credit 1 or more each semester. On-the-job training under supervision of practicing engineers in settings appropriate to professional objectives. Prerequisites: Approval of committee chairman and department head.

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

W. A. Brown, W. L. Buckingham*, C. D. Claycamp, J. W. Craig, Jr. (Interim Head), J. de Jong, C. M. Hix, Jr., R. P. Maher, J. H. Marsh III, A. Pedulla, N. D. Stubbs, F. J. Trost

*Graduate Advisor

The master of science in construction management is offered to students seeking professional opportunities in the construction industry. The degree program emphasizes knowledge of the construction process as the basis for a career as a developer, contractor, owner, or operator of the built environment. A core curriculum (18 hours) is complemented by 18 hours of interdisciplinary study selected to support individual student career goals.

(B.C.)

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: B.C. 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: B.C. 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: B.C. 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: B.C. 479 or approval of instructor. Cross-listed with C.E. 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: B.C. 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.

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.

DAIRY SCIENCE

(See Animal Science)

DEPARTMENT OF ECONOMICS

J. W. Allen, R. K. Anderson, L. Auernheimer, R. L. Basmann, R. C. Battalio, S. G. Bronars, E. K. Browning, T. F. Cosimano, R. F. Gilbert, M. L. Greenhut, J. M. Griffin, T. J. Gronberg*, J. R. Hanson II, H.-S. Hwang, W. J. Lane, Jr., S. C. Maurice, J. R. Moroney, S. Pejovich, O. R. Phillips, M. O. Reynolds, T. R. Saving, D. P. Schutte, C. W. Smithson, S. N. Wiggins

*Graduate Advisor

Graduate study in economics is offered leading to the degrees of master of science and doctor of philosophy. Curricular offerings are designed to equip the student with specialized knowledge for careers in teaching, government and business and to give a

sound preparation for continuing graduate study toward the doctorate elsewhere. There is no general Ph.D foreign language requirement.

Prerequisites: To major in economics, the student should present undergraduate credits of 30 semester hours in economics, business administration and the social sciences, of which 21 should be in economics. A strong quantitative background involving work in mathematics and statistics may be used to waive this requirement.

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 the period 1776-1848. Original works of Smith, Malthus, West, Ricardo and Mill. Prerequisite: Approval of department head.

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 department head.

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: Approval of department head.

605. American Economic Development in World Perspective. (3-0). Credit 3. American economic development between 1800 and the mid-20th century; relationship of American experience to international trends. American economic growth treated as a special case of modern economic growth which appeared following the Industrial Revolution in England.

607. Foundations of Microeconomic Theory. (3-0). Credit 3. Role of prices in directing the actions of individuals and groups of individuals in the processes of production, exchange and consumption of goods and services. Prerequisite: 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. 607 or equivalent.

610. Human Resource Economics II. (3-0). Credit 3. Selected topics and 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. 609.

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.

615. The American Economy I. (3-0). Credit 3. Brief survey of development of competitive economic system. Analysis of market system; behavior of both individual and firm. Fluctuations in level of economic activity and macro analytical tools required for understanding causes of such fluctuations. Prerequisite: Graduate classification or approval of department head.

616. The American Economy II. (3-0). Credit 3. Policy; application of micro and/or macro analytical tools to selected problem areas: public finance, international trade and finance, pollution, energy and regulation of business. Prerequisite: Graduate classification or approval of department head.

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 department head.

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 department head.

622. Regional Science II. (3-0). Credit 3. Regional economic analysis; price discrimination theory and practice, urban and regional economic planning, regional industrial complex analysis, cost-benefit analysis and economic base analysis. Prerequisite: Approval of department head.

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 department head.

629. Microeconomic Theory I. (3-0). Credit 3. Rigorous and analytical study of determination of prices and quantities of products, composition of national product, and allocation of resources. Students obtain detailed and comprehensive knowledge of literature so that they may act as teachers, researchers and consultants. Prerequisite: Approval of department head.

630. Microeconomic Theory II. (3-0). Credit 3. Rigorous theoretical analysis of the theories of production, cost, factor pricing and factor usage, distribution and general equilibrium. Prerequisites: Econ. 629; Ecmt. 660.

635. Monetary Theory. (3-0). Credit 3. Traditional as well as modern theories of money. General equilibrium systems and role of money in determination of prices, interest rate, income and employment. Factors influencing demand for money as well as its supply. Prerequisite: Econ. 636.

636. Macroeconomic Theory. (3-0). Credit 3. Aggregate economic 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. Scope of governmental regulation in economy of U.S., its evolution and development. Application of tools of economic analysis to problems posed by regulated enterprise. Prerequisite: Econ. 425 or approval of department head.

642. Comparative Economic Systems. (3-0). Credit 3. Impact of economic systems on various aspects of welfare; per capita income, growth, equity, stability, etc. Interrelations among property rights, incentives and economic behavior. Effects of alternative legal structures, rules, traditions and institutions on efficiency in production and distribution. Applications to selected case studies. Prerequisite: Approval of department head.

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 and Economic Regulation. (3-0). Credit 3. Industry structure, conduct, and performance described and analyzed with tools of microeconomics. Prerequisite: Approval of department head.

650. Advanced Industrial Organization. (3-0). Credit 3. Behavior of markets operating under conditions of imperfect information. Construction and scientific evaluation of models designed to explain industry performance. Preparation and presentation of student research on theoretical and empirical problems. Prerequisite: Econ. 649 or approval of department head.

651. International Economic Policy. (3-0). Credit 3. Interpretation of balance of payments and adjustment to national and international equilibria, through changes in price levels, exchange rates and national incomes. Making international payments, 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.

655. Studies in Experimental Economics I. (3-0). Credit 3. Application of experimental methods to issues of interest to economists and related social scientists; choice behavior experiments, survey research, planned economic environments and animal experiments. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Reports and discussions of current research and presentations by visiting economists. Prerequisite: Graduate classification.

85. Problems. Credit 1 to 3 each semester. Individual problems not related to thesis or dissertation. Prerequisites: Graduate classification with major or minor in economics; approval of department head.

89. 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.

90. 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.

91. Research. Credit 1 or more each semester. Thesis research.

See Ag.Ec. 603 and 633 for description of related courses.

ECONOMETRICS
(Ecmt.)

60. Mathematical Economics. (3-0). Credit 3. Use of selected types of mathematical tools in economic theory. Prerequisite: Econ. 323.

61. Mathematical Economics. (3-0). Credit 3. Fundamental properties of integral calculus, difference and differential equations, and their use in economic theory. Prerequisite: Ecmt. 660 or equivalent.

62. Logical Foundations of Economic Science. (3-0). Credit 3. Specialization of the language of economics; properties and relations of first-order economic theories; logical analysis of first-order economic theories and their empirical interpretations; economic applications of logic of quantity and magnitude; measurement in economics. Prerequisite: Approval of instructor.

63. Econometrics. (3-0). Credit 3. Use of statistics in economic theory as device for testing hypotheses, formulation concepts and economic forecasting. Prerequisites: Ecmt. 660; Stat. 608.

64. Intermediate 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. Prerequisite: Ecmt. 662, differential and integral calculus or approval of instructor.

65. Econometric Theory and Programming. (3-0). Credit 3. Stochastic and non-stochastic 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 department head.

66. Model Building in Econometrics. (3-0). Credit 3. Non-stochastic and stochastic model formulation. Identification, methods of solution and/or estimation, economic interpretations and applications of theory and methods to economic problems. Tools of mathematical and variational programming and statistics used to present received theory and to solve newly formulated problems. Prerequisite: Ecmt. 663.

68. Economics of 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.

69. 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.

70. Advanced Mathematical Economics. (3-0). Credit 3. Basic results from demand and production theory are unified by the duality concept of the envelope theorem. 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.

74. Econometric Theory II. (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.

DEPARTMENT OF EDUCATIONAL ADMINISTRATION

R. I. Berridge, M. J. Bratlien*, G. B. Chisolm, D. C. Corrigan, D. A. Erlandson (Head), H. L. Hawkins, D. Hinojosa, J. R. Hoyle, J. F. McNamara, S. L. Stark, P. T. West

*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, community college (and other higher education), school law and management, public relations, school special services, 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: Ed.Ad. 610, Ed.Ad. 625, Ed.Ad. 626, Ed.Ad. 655, Ed.C.I. 606, Ed.C.I. 649, E.Psy. 669, E.Psy. 670, I.Ed. 604, Id.Ed. 645 and Sa.Ed. 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.

(Ed.Ad.)

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: Ed.Ad. 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. The School Superintendency. (3-0). Credit 3. Organization and administration of systems of schools and their relationships on federal, state, intermediate and local levels. Private, parochial and adult education. Prerequisite: Ed.Ad. 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: Ed.Ad. 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.

625. The Community College. (3-0). Credit 3. Purposes, programs, people, organization, control and resources of the community college.

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: Ed.Ad. 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: Ed.Ad. 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: Ed.Ad. 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: Ed.Ad. 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.

642. Community Education: Planning and Administration. (3-0). Credit 3. Planning and administration of community education. Skills and techniques of incorporating the community education philosophy into the community and the K-12 program. Prerequisites: Ed.Ad. 641; approval of instructor.

651. Orientation in Business Principles and Procedures. (3-0). 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. Roles of superintendent and school business official. 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.

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.

680. Proseminar. (1-0). Credit 1. Major concepts, principles and issues in education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Required of all Ed.D. students. May be repeated for credit. Prerequisite: Approval of instructor.

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. (3-0). Credit 3. 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, D. W. David, J. J. Denton, C. J. Dockweiler*, J. Garcia, D. C. Godwin, R. K. James, D. L. Janke, G. R. Johnson*, R. J. Kansky, J. B. Kracht*, J. E. Morris‡, D. E. Norton, W. H. Peters (Head), J. H. Rollins, W. H. Rupley, M. C. Sadoski, T. V. Savage, A. C. Seaman, R. E. Shutes*, J. C. Stansell, W. F. Stenning*, D. L. Wiseman

*Graduate Advisor
‡Certification 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. 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: Ed.Ad. 610, Ed.Ad. 625, Ed.Ad. 626, Ed.Ad. 655, Ed.C.I. 601, Ed.C.I. 606, Ed.C.I. 649, E.Psy. 669, E.Psy. 670, I.Ed. 604, Id.Ed. 645 and Sa.Ed. 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 and secondary school supervisor.

(Ed.C.I.)

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.

604. Reading Diagnosis. (2-3). Credit 3. Appraisal and diagnosis of reading problems. Practicum in administration and interpretation of individual reading inventories. Prerequisite: Ed.C.I. 649, 674 recommended.

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.).

606. Foundations of Higher Education. (3-0). Credit 3. Change, continuity and controversy in higher education from the medieval prototype to the modern multiversity. Developments, analysis and interpretation of causes and effects; educational and social policies, institutional control, curriculum and teaching-learning.

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.

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.

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 Ed.C.I. 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.

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.

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: Ed.C.I. 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.

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: Ed.C.I. 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.

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: Ed.C.I. 351, 604.

43. 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.

44. Curriculum Development. (3-0). Credit 3. Curriculum development. Bases of curriculum design. Problems of balance, scope, organization, sequence, selection and articulation.

45. 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: Ed.C.I. 402.

46. 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: Ed.C.I. 675.

47. 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: Ed.C.I. 644.

48. 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: Ed.C.I. 644 and 647 or approval of instructor.

49. 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.

50. 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: Ed.C.I. 649 and 674, or approval of instructor.

52. 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.

53. 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.

54. 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.

55. 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: Ed.C.I. 644.

62. 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.

70. 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.

72. 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.

73. 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.

74. 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.

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: E.Psy. 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 the Disadvantaged. (2-2). Credit 3. Research concerning the cognitive and affective aspects of learning relative to students from low socioeconomic status backgrounds. Practical applications to curriculum and instruction.

680. Proseminar. (1-0). Credit 1. Structured seminar on major concepts, principles and issues in education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Required of all Ed.D. students. May be repeated for credit. 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.

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

C. R. Anderson, M. J. Ash (Head), D. G. Barker, A. Barona, W. G. Birch, G. M. Boodoo, C. A. Borman, L. A. Boyd, M. Duffy, E. T. Goetz, R. J. Hall, L. H. Hope*, J. N. Hughes, J. T. Kapes, J. J. Koldus III, C. E. McCandless, 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

*Graduate Advisor

The Department of Educational Psychology offers study for the Ph.D. degree in educational psychology, counseling psychology and school psychology. 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 employ-

ment 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 school settings, university training programs and other health care settings. Each of the other 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 and college student personnel services. School counseling prepares students for certification by the Texas Education Agency as school counselors.

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.

The deadline for fall admissions to all programs is February 1. Admissions are announced on April 1.

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: Ed.Ad. 610, Ed.Ad. 625, Ed.Ad. 626, Ed.Ad. 655, Ed.C.I. 601, Ed.C.I. 606, Ed.C.I. 649, E.Psy. 669, E.Psy. 670, I.Ed. 604, Id.Ed. 645 and Sa.Ed. 624 — see the separate departments within the College of Education.

EDUCATIONAL PSYCHOLOGY
(E.Psy.)

602. Educational Psychology. (3-0). Credit 3. Scientific concepts of learning, memory and the principle influences in learning process. Effects of development, aptitude, motivation and environment on learning. Role of tests in learning.

612. Individual Assessment in Education. (3-0). Credit 3. Educational 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: E.Psy. 622, Psy. 624; approval of department head.

614. Laboratory in Educational 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 E.Psy. 612.

615. Individual Assessment of Preschool Children. (3-2). Credit 4. Theory and techniques of psychological and developmental assessment of children from 2 1/2 to 8 1/2 years: specific skills for assessment developed; practice in preparing psychological reports. Prerequisites: E.Psy. 612 and 614 or equivalents.

617. Emotionally Disturbed Children: Diagnosis and Educational Intervention. (3-0). Credit 3. Diagnostic procedures and techniques in identification of emotionally disturbed children and youth, educational intervention strategies, individual educational plans (IEPs) and classroom management techniques.

618. Psychological Services in the Schools. (3-0). Credit 3. Practices and procedures of the psychologist in the school setting. Ethical and legal considerations, professional relationships, and emerging trends and issues.

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: E.Psy. 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. Prerequisite: E.Psy. 439 or 622.

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: E.Psy. 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: E.Psy. 622; approval of department head.

628. Consultation: Theory and Techniques. (3-0). Credit 3. History and theory of various models of consultation in educational psychology. Skills and techniques necessary for effective consultation. Relevant research issues. Prerequisites: E.Psy. 618; E.Psy. 612; E.Psy. 614 or 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.

630. Foundations of Guidance. (3-0). Credit 3. Philosophical, psychological and sociological concepts fundamental to guidance 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. Prerequisites: E.Psy. 622 or 630; Psy. 634.

632. Educational and Occupational Information. (3-0). Credit 3. Theories of career development, sources, classification, and analysis of educational and occupational and social information. Occupational trends, local occupational surveys. Use of occupational information by classroom teacher and guidance specialist.

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: E.Psy. 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: E.Psy. 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: E.Psy. 639, 633, 634 and application six weeks prior to registration.

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. Prerequisite: Six hours of statistics.

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: E.Psy. 631; approval of department head six weeks prior to registration.

640. Practicum in Consultation. (0-10). Credit 3. Supervised practice in the application of consultation strategies and techniques in educational psychology in a variety of settings. Off-campus consultation with schools and other agencies. Prerequisites: E.Psy. 628 and approval of instructor.

NOTE: This course was approved as E.Psy. 629. The Graduate College was informed on October 15, 1984, that the number of the course is to be 640 since 629 had been used recently.

646. Issues in Child and Adolescent Development for Educators. (3-0). Credit 3. Theoretical orientations, issues, research strategies and empirical findings of developmental psychology relevant to education. Prerequisite: Psy. 634 or equivalent.

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: E.Psy. 639; approval of department head six weeks prior to registration.

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.

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: E.Psy. 664, approval of department head and application six weeks prior to registration.

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.

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: E.Psy. 631.

673. Learning Theories for Educators. (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: E.Psy. 673; approval of instructor.

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: E.Psy. 664, 672 and approval of department head.

676. Marriage and Family Counseling. (3-0). Credit 3. Basic concepts and techniques in marriage and family counseling. Marital communication and growth relationships. Prerequisites: E.Psy. 631, 633 and approval of department head.

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. Prerequisite: Psy. 635, human service experience or approval of instructor.

680. Proseminar. (1-0). Credit 1. Structured seminar on major concepts, principles and issues in education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Required of all Ed.D. students. May be repeated for credit. Prerequisite: 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 repeated for 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 — Guidance
c — Educational Assessment
d — School Psychology
e — Counseling Psychology
f — Instructional Psychology
g — Applied Research
k — 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.

SPECIAL EDUCATION
(Sp.Ed.)

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: Sp.Ed. 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: Sp.Ed. 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: Sp.Ed. 613.

616. Field Experiences in Special Education. (1-6). Credit 3. Participation in an approved special education program. Supervised by course professor and a certified professional in special education. A minimum of 150 hours of scheduled, supervised experience, daily log of pertinent activities and an in-depth case study required. Prerequisites: E.Psy. 614 or Sp.Ed. 615; approval of department head.

EDUCATIONAL TECHNOLOGY
(See Industrial, Vocational and Technical Education)

DEPARTMENT OF ELECTRICAL ENGINEERING

P. E. Allen, Y. Anjaneyulu, A.-K. Ayoub, S. P. Bhattacharyya, R. K. Cavin III, A. K. Chan, M. Ehsani, O. Eknoyan, T. R. Fischer, R. L. Geiger, J. D. Gibson, D. M. Green, N. C. Griswold, D. R. Halverson, J. W. Howze* (Interim Head), B. R. Jean, W. B. Jones, Jr., J. S. Kilby, R. D. Nevels, R. W. Newton, P. S. Noe, J. H. Painter, R. K. Pandey, D. L. Parker, A. D. Patton, W. A. Porter, V. T. Rhyne, B. D. Russell, E. Sanchez-Sinencio, C. Singh, N. R. Strader II, M. A. Styblinski

*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 specialization include digital systems and computers, communications, controls, linear and nonlinear systems theory, digital signal processing, solid state electronics, analog circuits, power, electromagnetics and instrumentation systems. Interdisciplinary engineering programs are available with other areas of specialization.

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, remote sensing and electric power systems. A DEC VAX 11/782 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.

(E.E.)

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.

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: E.E. 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: E.E. 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: E.E. 460 or approval of instructor.

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: E.E. 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: E.E. 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: E.E. 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: E.E. 605.

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: E.E. 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: E.E. 322 and 351 or equivalent.

636. Principles of Radar Systems Design. (3-0). Credit 3. Elements of modern radar system design, fundamental constraints on time, energy and bandwidth; radar equation, target characteristics, antenna considerations, waveform design, detection, resolution, digital signal meters, air traffic control radars and other systems. Prerequisite: E.E. 601 or approval of instructor.

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: E.E. 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.

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: E.E. 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: E.E. 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 E.E. 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: E.E. 646 or equivalent probability background.

648. Electromagnetic Wave Propagation. (3-0). Credit 3. Electromagnetic surface waves; wave refraction, reflection and scattering; boundary value problems in electromagnetic wave propagation; application of asymptotic, analytical and numerical methods. Prerequisite: E.E. 351.

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: E.E. 646, 605.

651. Microprogrammed Control of Digital Systems. (3-0). Credit 3. 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: E.E. 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. Electronic Computer Design. (3-3). Credit 4. Design of digital computers; arithmetic unit design, control and memory. High-speed addition, subtraction, multiplication and division; micro- and macro-programming; magnetic memory devices. Design with integrated circuit components; MSI devices. Prerequisite: E.E. 348.

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: E.E. 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: E.E. 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.

658. Magnetism and Magnetic Devices. (3-0). Credit 3. Theory of magnetism and magnetic devices with emphasis on amorphous magnetism, magnetic-absorber and bubble domains. Prerequisites: E.E. 370 and 322 or Phys. 424 or equivalent.

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: E.E. 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: E.E. 646.

665. Electric Power Systems Engineering. (3-0). Credit 3. Electric power system engineering: transient voltages in power systems, electric utility economics, evaluation of power generation sources, d-c power transmission, load forecasting and current problems of interest. Group study, reports, design problems. Prerequisites: Graduate classification; approval of instructor.

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: E.E. 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: E.E. 460 or approval of instructor.

670. Microwave Semiconductor Devices. (3-0). Credit 3. Basic theory of solid state microwave devices and mathematical formulations leading to the development of their equivalent circuits. Tunnel diode, IMPATT diode, BARITT diode, Schottky gate FETs and IMPATTs, bulk-effect devices, Gunn diode, optoelectronic devices. Prerequisites: E.E. 656 or registration therein; graduate classification.

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: E.E. 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.

675. Synthesis and Characterization of Solid State Materials. (3-0). Credit 3. Phase diagrams, structure and crystal growth techniques. Methods of characterization of materials on technical application. Prerequisites: E.E. 325 and 370 or equivalents.

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: E.T. 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.

DEPARTMENT OF ENGINEERING DESIGN GRAPHICS

J. T. Coppinger*, J. H. Earle* (Head), R. A. Hartman, T. C. Pollock

*Graduate Advisor

Special problems can be taken in engineering design graphics with the approval of the EDG department and the student's degree-granting department.

Modern facilities and current equipment are available to enhance study and instruction. These facilities include a graphics library, a reproduction and visual aids center, photographic and darkroom facilities, a computer graphics facility and special equipment.

(E.D.G.)

685. Problems. Credit 1 to 4 each semester. Special research problems to fit needs of the individual student. Prerequisites: E.D.G. 106; graduate classification; approval of instructor.

DEPARTMENT OF ENGLISH

D. R. Anderson, H. Andreadis, S. L. Archer*, G. H. Bailey, R. W. Barzak, D. A. Berthold*, F. D. Burt*, M. B. Busby, G. H. Cannon, P. Christensen, W. B. Clark, R. H. Costa, J. N. Cox, T. W. Crusius, D. R. Dickson, C. L. Gibson, G. Gong, J. S. Graham, S. A. Grider, P. C. Hunter, Jr., C. W. Kallendorf, R. S. Kellner, H. P. Kroitor, J. Loving, E. McDaniel, C. Machann, K. O.'B. O'Keeffe, P. A. Parrish, J. H. Powers, K. M. Price, L. J. Reynolds, K. W. Ritter, D. H. Stewart* (Head), E. Tebeaux, W. C. Turner, J. E. Van Domelen, E. C. Want

*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, or rhetoric and composition.

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 must include a minor of 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 the Graduate College. 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.

610. History of the English Language. (3-0). Credit 3. Cross-listed with 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. Prerequisite: Approval of instructor. Cross-listed with B.A. 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.

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.

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. Composition Background and Models. (3-0). Credit 3. Development of composition theory from the late 1800's to the present; specific models of composition instruction in theory and practice. Prerequisites: Graduate classification; approval of instructor.

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. Cross-listed with Engl. 605. Credit cannot be given for both Engl. 605 and Ling. 605.

606. Beowulf. (3-0). Credit 3. 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.

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.

612. Chaucer. (3-0). Credit 3. 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. 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, R. E. Frisbie, T. W. Fuchs, F. E. Gilstrap, O. H. Graham, K. F. Harris, M. K. Harris, R. L. Harris, J. A. Jackman, K. J. R. Johnson, J. S. Johnston, L. L. Keeley, G. M. McWhorter, F. G. Maxwell* (Head), R. T. Mayer, Jr., R. W. Meola, J. K. Olson, T. L. Payne, F. W. Plapp, D. R. Rummel, J. C. Schaffner*, M. F. Schuster, J. E. Slosser, J. W. Smith, Jr., W. L. Sterling, 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., R. A. Wharton

*Graduate Advisor

Work is offered in the various stages 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 1984-85 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.

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.

607. Economic Entomology. (3-3). Credit 4. Biologies, economic importance and control of insects and other arthropods from a pest management viewpoint. Team taught by instructors specialized in various aspects of entomology. For non-entomology majors only with special emphasis on the needs of county agricultural agents, vocational agriculture teachers and private consultants. Prerequisite: Ento. 201 or equivalent.

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. Invertebrate Pathology. (3-3). Credit 4. General invertebrate pathology and microbiology; noninfectious and infectious diseases of invertebrates, the biological relationships between microorganisms and invertebrates, and application of entomogenous pathogens in entomology. Prerequisite: One course in microbiology and Ento. 313 or equivalent; 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 discussion of assigned reading and lectures. Prerequisite: Approval of instructors. Cross-listed with Agro. 610 and Pl.Pa. 610.

615. Insect Physiology. (3-3). Credit 4. 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.

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 1985-86 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 non-target organisms. Prerequisite: One course in organic chemistry, Ento. 615 or approval of instructor.

620. Insect Biochemistry and Endocrinology. (3-0). Credit 3. Recent information and concepts in the area of insect biochemistry. Intermediary metabolism and its regulation by hormones and the role of hormones in insect growth and development. Prerequisite: Background in physiology or biochemistry; or approval of instructor. (Offered in 1984-85 and alternate years thereafter).

621. Biology and Systematics of Entomophagous Insects. (1-6). 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.

622. Application Theory of Biological Control. (3-0). Credit 3. Theories of population growth and stabilization; role of biotic environmental resistance; tactics for implementing biological control and characterizing effective biological control agents.

624. Dynamics of Wild Animal Populations. (2-3). Credit 3. Principles, models and methods for anaylsis 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 W.F.S. 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

S. K. Cooper, D. A. Dubofsky, W. E. Etter**, D. R. Fraser*, J. P. Friedman, J. C. Groth, R. L. Haney, Jr., J. Harris, J. W. Kolari, S. L. Lummer, A. Mahajan, C. A. Phillips, R. M. Richards (Head), P. S. Rose, G. C. Uselton

*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. These programs provide training in financial management.

The M.B.A. degree program consists of 48 credit hours of which 12 credits hours may be taken in the department. Areas of course work include corporate finance, management of financial institutions, investment management, money and capital markets and real estate finance. 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.

(Fin.)

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. Prerequisites: Acct. 640; B.Ana. 646.

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. Prerequisites: Acct. 640; Fin. 629.

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: Fin. 629 or approval of instructor.

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: Fin. 630 or approval of instructor.

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.

636. Financial Management for Non-Business II. (3-0). Credit 3. Financial management of the business firm; financial analysis, financial planning and asset management. Prerequisite: Fin. 635 or approval of graduate advisor.

637. Issues and Practices in Corporate Finance. (3-0). Credit 3. Financial theory and analysis. Case analysis is used, focusing on the financial decision-making process. Prerequisite: Fin. 630 or equivalent.

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: Fin. 629, 635 or approval of instructor.

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: Fin. 629, 635 or approval of instructor.

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: Fin. 629, 635 or approval of instructor.

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 Fin. 629.

660. State and Local Financial Administration. (3-0). Credit 3. Financial problems confronted by large cities. Principal problems of public financial management; planning, programming and budgeting; tax assessment and administration; debt management; financial reporting. Prerequisites: Graduate classification; approval of instructor.

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: Fin. 629, 635 or approval of instructor.

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: Fin. 629, 635 or equivalent or approval of instructor.

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. Prerequisite: Fin. 629 or 635 and Acct. 640 or approval of instructor.

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. 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, O. D. Butler, Jr., L. M. Canfield-Sander, Z. L. Carpenter, A. B. Childers, Jr., H. R. Cross, C. W. Dill, G. Finne, F. A. Gardner, N. D. Heidelbaugh, G. T. King, K. S. Kubena, O. R. Kunze, W. A. Landmann, F. A. Orts, 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

The interdepartmental curriculum in food science and technology is administered through the office of the dean of the College of Agriculture. 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.

(F.S.T.)

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 D.S. 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 An.Sc. 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 D.S. 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 P.S. 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; F.S.T. 314 or approval of instructor.

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 An.Sc. 647.

657. Food Additives, Ingredients and Regulatory Compliance. (3-0). Credit 3. Identification nomenclature, purpose and function of additives used in meat and non-meat food products. Governmental regulatory agencies, their organization and control over food ingredient labeling; commercial supplies and basic manufacturing operations used in food ingredients. Prerequisite: Approval of instructor. Cross-listed with An.Sc. 657.

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 An.Sc. 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*, J. C. Lee (Head), W. J. Lowe, C. R. McKinley, R. C. Maggio, J. G. Massey, R. G. Merrifield, R. J. Newton, J. O'Laughlin, T. L. Payne, E. J. Soltes, J. P. van Buijtenen

*Graduate Advisor

The objective of graduate education in the Department of Forest Science is to provide opportunities to extend knowledge and skills beyond those received at the baccalaureate level. Toward this end, the department offers programs leading to the M.Agr., M.S. and Ph.D. degrees.

Candidates for the M.Agr. degree pursue a multidisciplinary program in natural resources development. This professional program is relatively broad in scope and offers opportunities for student involvement in management and operational activities in the natural resource field. Candidates for the M.S. or Ph.D. degrees specialize in forestry-related fields such as administration, ecology, economics, harvesting, management, measurements, physiology, protection, remote sensing, silviculture, tree improvement, wood chemistry and wood energy. Most of the course work in these specialties is interdisciplinary in nature and available through other departmental units within the University including biology, business administration, chemistry, computer science, economics, engineering, entomology, genetics, plant and soil sciences, and statistics.

Specific graduate study programs in the forest sciences, especially for the Ph.D. degree, usually require some breadth in several disciplines, different for each course of

study, and dependent on candidate backgrounds. As such, support course content in degree programs must be tailored to the background and educational goals of each degree candidate in consultation with his or her graduate committee.

(F.S.)

501. 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.

502. Advanced Silviculture. (3-0). Credit 3. Advanced silvicultural methods, techniques and problems; current research and technical literature. Prerequisite: F.S. 305 or equivalent.

506. 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.

507. 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.

533. 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: Gen. 603. Cross-listed with Gen. 633. (Offered in 1985-86 and in alternate years thereafter.)

534. 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: Gen. 633. Cross-listed with Gen. 634.(Offered in 1985-86 and in alternate years thereafter.)

561. 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 C.E. 661.

581. 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.

584. 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.

585. 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.

589. 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.

591. Research. Credit 1 or more each semester. Research in an approved aspect of forest science for thesis or dissertation credit.

GENETICS

K. J. Aufderheide, T. O. Baldwin, E. C. Bashaw, C. R. Benedict, J. W. Bickham, L. S. Bird, A. J. Bockholt, D. L. Busbee, T. C. Cartwright, R. C. Fanguy, J. R. Gold, I. F. Greenbaum, T. C. Hall, G. E. Hart, J. S. Johnston, N. M. Kieffer, R. J. Kohel, W. F. Krueger, H. O. Kunkel, W. J. Lowe, C. R. McKinley, C. W. Magill, J. M. Magill, F. R. Miller, J. C. Miller, Jr., J. L. Nordstrom, W. D. Park, D. O. Peterson, H. J. Price, P. J. Rizzo, J. O. Sanders, K. F. Schertz, D. J. Schmidly, G. L. Schroeter, J. D. Smith, M. D. Summers, J. W. Templeton, T. L. Thomas, J. P. van Buijtenen, J. R. Wild (Chairman), H. D. Wilson, J. E. Womack

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 and somatic cell genetics as well as biotechnology, 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 the Departments of Animal Science, Biochemistry and Biophysics, Biology, Entomology, Forest Science, Plant Sciences, Poultry Science, Range Science and Soil and Crop Sciences. Graduate assistantships and fellowships are available in each department. Applications to the Graduate College should specify the department in which the student expects to do research. The language requirement will be determined by the student's administrative department.

Listed below are the graduate courses in genetics followed by departmental listings:

(Gen.)

603. Genetics. (4-0). Credit 4. Development of fundamental concepts related to the structure, function, organization, transmission and distribution of genetic material. Prerequisite: Gen. 301.

604. Genetics Laboratory. (0-3). Credit 1. Laboratory techniques and methods in genetics: introduction to biological genetic systems. Prerequisite: Gen. 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: Gen. 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: Gen. 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: Gen. 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: Gen. 603, Stat. 651.

613. Quantitative Genetics I. (3-0). Credit 3. Quantitative genetics concepts particularly dealing with partition of phenotypic variance into genetic and environmental components, selection response, effects of systems of mating, genetic covariance and threshold effects. Prerequisites: Gen. 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: Gen. 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: Gen. 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 Gen. 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: Gen. 603. Cross-listed with F.S. 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: Gen. 633. Cross-listed with F.S. 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; and somatic cell genetics in higher plants. Prerequisite: Gen. 301 or Gen. 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.

691. Research. Credit 1 or more each semester. Prerequisite: Gen. 603.

ANIMAL SCIENCE
(An.Sc.)

616. Quantitative Genetics II. (3-0). Credit 3.

628. Animal Breeding. (2-2). Credit 3.

BIOCHEMISTRY
(Bich.)

631. Biochemical Genetics. (3-0). Credit 3.

FOREST SCIENCE
(F.S.)

633. Forest Genetics. (3-0). Credit 3.

634. Forest Genetics Laboratory. (0-3). Credit 1.

POULTRY SCIENCE
(P.S.)

613. Concepts of Breeding Systems. (3-0). Credit 3.

RANGE SCIENCE
(R.S.)

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.

DEPARTMENT OF GEOGRAPHY

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., 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, and students are encouraged to work in physical, biological and social sciences. Staff interests include cultural, historical, behavioral, resource, plant geographical, geomorphic, urban and economic studies.

Graduate students are expected to be involved with research work throughout their studies. Primary data collection is encouraged. Most graduate courses are taught as seminars requiring research papers. A non-thesis option is available for master's level students.

A number of the courses listed below are offered in alternate years. Requests for schedule information should be directed to the department head.

(Geog.)

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.

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 research and/or reconstruction of ships. Prerequisites: Anth. 612, 615. Cross-listed with Anth. 616.

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.

635. Man in Extreme Environments. (2-2). Credit 3. Human adjustment to novelty, risk and stress in environment: the arctic, desert and tropics; high altitude and submarine environments; the "battlefield" and other high risk regions of earthquake, tornado, hurricane and flood. Strategies of adjustment, control and adaptation. Research paper. 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, G. P. Eaton, E. L. Estes III, R. C. Fletcher, M. Friedman, S. J. Fritz, L. E. Garrison, J. R. Giardino, M. C. Gilbert (Head), E. L. Grossman, A. Hajash, Jr., E. R. Hoskins, B. Johnson, K. J. Koenig, J. M. Logan, C. C. Mathewson, J. M. Mazzullo, D. W. Mohr, R. K. Popp, A. L. Raymond, M. C. Schroeder, J. H. Spang, R. J. Stanton, Jr., T. T. Tieh, 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 groundwater 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.

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 the Graduate College requirements for the Ph.D., the student's committee chairman, 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 2 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.

19. 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.

20. 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.

22. 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.

23. 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.

29. 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.

30. Urban Geology. (2-2). Credit 3. Fundamentals of engineering geology as applied to the planning, development and design of urban areas; properties of Earth materials, land form analyses and geologic processes. Designed as service course for graduate students interested in urban studies, planning, design, etc. Not for civil engineering or geology majors. Prerequisite: Graduate classification.

31. 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. Prerequisite: Graduate classification in engineering or geoscience.

32. 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 geoscience.

34. Engineering Geology of Coal. (3-0). Credit 3. Engineering geology of coal: classification, geochemistry, environments of deposition as related to engineering geologic aspects of mine planning and design, environmental assessment, mine reclamation, regulation of mines, utilization and evaluation. Prerequisite: Graduation classification.

35. 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.

37. Fundamental Geology I. (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.

38. Fundamental Geology II. (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. Sedimentary petrology, stratigraphy and paleontology. Prerequisite: Approval of department head.

40. Aqueous and Sedimentary Geochemistry. (3-0). Credit 3. Basic solution geochemistry and equilibria concepts 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.

46. Geology and Diagenesis of Clays. (2-3). Credit 3. Geologic significance and role of clay minerals and related phyllosilicates in the depositional and diagenetic environments. 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 1985-86 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 sandstones, 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, loose-grain mounts, polished slabs and acetate peels. 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 Ocn. 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.

681. Seminar. (1-0). Credit 1. Reports and discussions of current research and selected topics from geologic literature. 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

M. Caputo, R. L. Carlson, N. L. Carter, G. P. Eaton, D. A. Fahlquist, R. C. Fletcher, A. F. Gangi, T. W. C. Hilde, E. R. Hoskins (Head), B. Johnson, J. M. Logan, J. E. Russell, T. W. Spencer, R. R. Unterberger, R. J. Willemann

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 database 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.

606. Kinematic Aspects of Plate Tectonics. (2-0). Credit 2. Plate motions on planes and spheres, evolution of triple junctions, determination of relative and absolute poles of rotation, and the means by which such motions are described. Prerequisite: 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.

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.

627. Electromagnetic Wave Propagation in Earth Materials. (3-0). Credit 3. Maxwell's equations and electromagnetic wave propagation in vacuum, lossless dielectrics and lossy earth materials. Snell's law, Fresnel's equations, Brewster angle, radiation polarization types, attenuation, reflection and refraction. Criteria for invisibility, theory of dielectrics and its application to earth materials. Matching theory and practical applications of wave propagation to geophysical problems. Laser principles and applications of laser radar. Prerequisites: Knowledge of vectors and complex numbers; Phys. 416 or E.E. 451 or equivalent or approval of instructor.

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.

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 half-space. 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. (Offered spring 1985 and alternate years thereafter).

666. Principles of Geodynamics. (4-0). Credit 4. Prerequisite: Approval of instructor. Cross-listed with Geol. 666 and Ocn. 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

B. S. Beall, J. M. Chevrette, L. J. Dowell*, J. R. Elledge, C. P. Gabbard, R. S. Hurley, M. J. Little, R. H. Pender, L. D. Ponder* (Head), G. E. Richardson, 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 physical education 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 physical education may be earned in the department.

The department maintains laboratories in exercise physiology, motor learning, child movement, and kinematics for class use and for graduate students concentrating in these areas.

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.

A specialization in allied health teacher education and administrative leadership is offered in conjunction with Baylor College of Medicine. It is 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 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 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: Ed.Ad. 610, Ed.Ad. 625, Ed.Ad. 626, Ed.Ad. 655, Ed.C.I. 601, Ed.C.I. 606, Ed.C.I. 649, E.Psy. 669, E.Psy. 670, I.Ed. 604, Id.Ed. 645 and Sa.Ed. 624.

HEALTH EDUCATION
(H.E.)

601. Readings in Health and Physical Education. (3-0). Credit 3. Cross-listed with P.E. 601.

620. Sex Education in Schools. (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 and as a source of creative energy and total life development.

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.

626. Health Careers. (2-2). Credit 3. Allied health professions and other health related occupations; vocational opportunities. Laboratory experiences will include visitation and observations of practitioners in the field.

631. Community and Public Health. (3-0). Credit 3. Community health problems; public health laws; national, state and local health agencies.

636. Advanced Tests and Measurements. (2-2). Credit 3. Tests and measurements; methods of constructing and evaluating tests. Prerequisite: H.E. 425.

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: H.E. 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.

680. Proseminar. (1-0). Credit 1. Structured seminar on major concepts, principles and issues in health education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Prerequisite: Doctor of education student in the College of Education.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current interest in health education.

682. Seminar in . . . (1-0). Credit 1. Issues, developments and trends in school and public health education. Specific topics will be designated for each seminar as it is offered. Prerequisite: Approval of department head.

683. Practicum in Health Education. (1-6). Credit 3. Observations and study of health practices and methods used in school, public and institutional health settings. 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. Directed study of selected problems in health education.

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

690. Theory of Health Education Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of health 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 department head. Cross-listed with P.E. 690.

691. Research. Credit 1 or more. 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
(O.Ed.)

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.

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.

PHYSICAL EDUCATION
(P.E.)

601. Readings in Health and Physical Education. (3-0). Credit 3. Study of published reports and research in fields of health and physical education. Cross-listed with H.E. 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 program.

614. Philosophy and Principles. (3-0). Credit 3. Major schools of philosophical thought, leaders and forces affecting past and present development of physical education.

622. Supervision of Health and Physical Education. (3-0). Credit 3. Principles and processes of supervision; in-service training of personnel.

623. Administration of Health and Physical Education. (3-0). Credit 3. Administration of comprehensive programs of health, physical education and intramurals.

627. Kinesiology. (3-0). Credit 3. Science of human motion. Relationship between structure and function in accordance with general mechanical laws and interrelated factors. Prerequisite: P.E. 426.

628. Therapeutics. (3-0). Credit 3. Theories and techniques of muscle re-education and application of exercise to orthopedic, medical, post-surgical and neurological disorders. Administration and direction of therapeutic and adapted physical activity programs.

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. Prerequisites: P.E. 627; 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: Biol. 219, 220.

636. Advanced Tests and Measurements. (3-0). Credit 3. Tests and measurements; methods of constructing and evaluating tests. Prerequisite: P.E. 425 or equivalent.

637. Exercise Physiology. (2-2). Credit 3. Current research in human performance and sport physiology. The nature of cardiorespiratory fitness, muscular efficiency and related topics. Prerequisite: Biol. 652 or approval of department head.

638. Ergonomics. (2-2). Credit 3. Current methods of imposing work in the exercise physiology laboratory and current techniques for evaluating humans' physiological responses to work. Critical analysis of current research in the area of work physiology; physical work capacity in different environments. Prerequisite: P.E. 637; approval of department head.

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: P.E. 406.

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: P.E. 406.

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: P.E. 425.

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: R.P. 609 or approval of instructor. Cross-listed with R.P. 655.

680. Proseminar. (1-0). Credit 1. Structured seminar on major concepts, principles and issues in physical education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Prerequisite: Doctor of education student in the College of Education.

681. Seminar. (1-0). Credit 1. Reports and discussions of topics of current interest in physical education.

682. Seminar in . . . (1-0). Credit 1. Issues, developments and trends in physical education. Specific topics will be designated for each seminar as it is offered. Prerequisite: Approval of department head.

683. Practicum in Physical Education. (1-6). Credit 3. Observation and study of rehabilitation and physical education programs in schools and other institutions. Prerequisite: Approval of department head.

684. Professional Internship. Credit 1 to 6 each semester. Designed to give prospective physical education supervisors, administrators and corrective or physical therapist 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 of health, physical education and recreation not related to thesis.

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

690. Theory of Physical Education Research. (3-0). Credit 3. Theory and design of research problems and experiments in various subfields of physical 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 department head. Cross-listed with H.E. 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, G. C. Anderson, T. H. Anderson, A. C. Ashcraft, D. Baum, G. E. Bayliss, R. A. Beaumont, S. J. Black, J. C. Bradford, K. L. Bryant, Jr., W. L. Buenger, R. A. Calvert, L. D. Cress, H. C. Dethloff (Head), C. S. L. Dunning, B. D. Gooch*, C. H. Hall, L. D. Hill*, D. T. Knobel, Z. J. Kosztolnyik, A. P. Krammer, B. S. Ledbetter, J. H. Lenihan, D. J. Pisani, J. A. Pratt, H. C. Schmidt, D. E. Schob, B. E. Seely, P. Stranahan, A. N. Stranges, B. M. Unterberger, F. E. Vandiver

*Graduate Advisor

Graduate study in history is offered leading to the degrees of M.A. and Ph.D. (American history). The graduate program in history is designed to prepare students for careers of teaching and scholarship in schools, colleges and universities, and to train historical specialists for various branches of government, business and social service. The student may specialize in United States history, Texas history, business and economic history and history of science, agriculture and technology, military history and diplomacy.

Students will find acceptable minors in economics, education, English, management, marketing, political science, some areas of science, sociology, or other social sciences, or a field of history at the master's level other than the major field.

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 courses in history; and for a minor at least nine semester hours (including at least six advanced hours) in the minor field of study. Those interested in further information concerning the requirements for the M.A. or the Ph.D. (American history) should contact the departmental graduate advisor.

Normally for the Ph.D. in American history the student shall demonstrate a reading knowledge of two modern foreign languages, subject to the approval of the student's advisory committee. In unusual and exceptional cases, with the approval of said committee, a minimum of six semester hours of graduate work outside the major and minor fields of study, completed after the filing of a degree program, may be substituted for one language.

(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.

HORTICULTURAL SCIENCES

E. E. Burns, D. H. Byrne, S. D. Cotner, F. J. Dainello, F. T. Davies, Jr., T. K. Hartz, J. W. Kelly, J. A. Lipe, W. N. Lipe, G. R. McEachern, E. L. McWilliams, J. C. Miller, Jr., D. L. Morgan, A. E. Nightingale, D. R. Paterson, L. M. Pike, D. W. Reed*, J. B. Storey, H. Grant Vest, Jr. (Head)

*Graduate Advisor

FLORICULTURE

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.

(Flor.)

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.

617. Landscape Horticulture. (2-3). Credit 3. Relations of ornamental plants to environments. Basic underlying scientific principles involved in the culture and use of plants in the physical landscape environments of urban, suburban and rural areas. Culture and maintenance of plants in the landscape. Prerequisite: Flor. 609 or approval of instructor.*

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

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.

(Hort.)

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: P.Phy. 602 or approval of instructor.*

602. Environmental Relations of Horticultural Crops. (3-3). Credit 3. 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: P.Phy. 602 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: P.Phy. 602, Biol. 453 or approval of instructor.

605. 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.

614. Vegetable Propagation. (2-3). Credit 3. Reproduction and sexual interaction in ornamental, vegetable and fruit plants; flower development, embryology; fertilization; seed and fruit development; physiology of sex expression. Prerequisite: Approval of instructor.*

615. Origin and Distribution of Horticultural Plants. (2-3). Credit 3. Origin, distribution and morphology of ornamental, fruit and vegetable plants; center of origin; dispersal and migration; structure and function of principal tissues and organs. 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.

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 F.S.T. 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: R. P. Beals, L. T. Blank (Interim Head), G. L. Curry, B. L. Deuermeyer, N. C. Ellis, R. M. Feldman, J. W. Foster III, M. J. Fox, Jr., A. Garcia-Diaz, J. K. Hennigan, G. L. Hogg*, R. D. Huchingson, R. J. Koppa, D. T. Phillips, T. Sastri, R. E. Shannon, D. R. Smith, C. V. Wootan, R. E. Young

BIOENGINEERING: Y. Fares, D. S. Feldman, W. A. Hyman* (Program Coordinator), C. S. Lessard, G. E. Miller, P. J. Sharpe, H. Wu

INDUSTRIAL HYGIENE AND SAFETY ENGINEERING: W. L. Johnston, R. B. Konzen*, H. J. Suggs, R. J. Vernon (Program Coordinator)

*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 three degree programs: industrial engineering, bioengineering and safety engineering/industrial hygiene. The industrial engineering program offers the specialty areas of human factors engineering, management engineering, operations research and applied statistics, and production and manufacturing engineering. All of these programs and specialty 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 programs and specialty 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, manufacturing engineering, operations research and optimization, computer graphics, municipal systems 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, 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.

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
(B.E.)

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: E.E. 331 or equivalent; B.E. 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.

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: V.P.P. 335 or equivalent; B.E. 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: Bich. 410; B.E. 401; Math. 602; V.P.P. 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 Ag.En. 651 and Ch.E. 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 B.E. 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: B.E. 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; C.S. 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
(I.En.)

600. Industrial Engineering Concepts. (4-0). Credit 4. Survey of the major topic areas of classical industrial engineering; engineering economics, work measurements, production engineering, facilities planning and industrial labor relations. For non-industrial engineering graduates; cannot be used for credit toward a graduate degree in industrial engineering. Prerequisite: Approval of instructor.

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: I.En. 303, 416 or I.En. 600.

602. Assurance Sciences. (3-0). Credit 3. Introduction to the assurance sciences; topics in reliability, maintainability, quality control, design of experiments and forecasting. Prerequisite: Stat. 601 or I.En. 613 or equivalent.

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: I.En. 304 or 600 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: I.En. 416 or 600 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: I.En. 303, 304, and 315 or 600 or approval of instructor.

610. Advanced Manufacturing Processes. (2-3). Credit 3. Quantitative study of the nontraditional material removal and forming processes. Economic aspects as well as theory and industrial applications. Electro chemical machining, electrical discharge machining, high energy forming, and laser and electron beam machining. Prerequisite: I.En. 454 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. Prerequisite: I.En. 613, I.En. 620 or equivalent.

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. 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: I.En. 613 or equivalent.

615. Production and Inventory Control. (2-3). Credit 3. Development and application of techniques for demand 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: I.En. 613 or equivalent, I.En. 620 as corequisite.

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. Prerequisites: I.En. 613 or equivalent.

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: I.En. 613 and I.En. 620 or equivalent.

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. Prerequisites: I.En. 613, I.En. 620 or equivalent.

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. Prerequisite: I.En. 613 or equivalent.

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. Prerequisite: I.En. 320 and 613 or equivalent.

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: I.En. 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: I.En. 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. Prerequisites: I.En. 613, I.En. 620 or equivalent.

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. SLAM II stressed as a primary simulation language; fundamentals of GPSS, SIMSCRIPT and SIMAN. Prerequisites: I.En. 620 and I.En. 613 or equivalent.

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 I.En. 620 and 660 series or equivalent.

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: I.En. 613 and 620 and 303 or 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: I.En. 620 and 622 or 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 man-machine systems (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: I.En. 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. Background of understanding and relevant data to students concerned with 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: I.En. 630, 631.

636. Biological Control System Analysis. (3-0). Credit 3. Development of mathematical and electromechanical models of biological systems, and the derivation of human transfer function for design applications. Prerequisite: Approval of instructor.

637. Human Factors Engineering. (3-0). Credit 3. Human factors methods, models and problem areas; human performance and 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.

651. Machining Processes. (2-3). Credit 3. Use of computer and numerical control to achieve optimum conditions for industrial metal machining processes. The theory of metal cutting; analysis of the factors involved in obtaining conditions of minimum cost, maximum production and maximum profit. Prerequisite: I.En. 454 or equivalent.

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: I.En. 615, I.En. 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. Prerequisites: I.En. 615 or I.En. 315, I.En. 652 or equivalent.

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: I.En. 613 and I.En. 620 or equivalents.

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: I.En. 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. Prerequisite: I.En. 615, 620 and 623 or equivalent.

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: I.En. 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 second 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 chairman 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
(S.Eng.)

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.

676. Safety in Materials Handling. (3-0). Credit 3. Manual and mechanical materials handling systems, selection, placement and training of personnel; selection of equipment, interaction of manual and mechanical systems, application of equipment standards and ergonomic principles.

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.

679. Safeguarding Mechanical Systems. (2-3). Credit 3. Mechanical systems, theory of mechanical safeguards, evaluation of mechanical systems, development of controls for hazards including noise, point-of-operation, power transmission, ventilation and maintenance. System analysis techniques applied.

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: S.Eng. 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: S.Eng. 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, J. L. Boone, Jr., R. Q. Brackett, Jr., M. L. Burger, M. L. Chastain, D. L. Clark, F. E. Clark, M. E. Dennis, G. Garcia, Jr., G. D. Gutcher, D. L. Householder* (Head), J. T. Kapes, L. H. Parrish

*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 educational technology, industrial education, safety education and 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. Students may also complete State of Texas course requirements for the professional teaching certificate in industrial arts or vocational industrial education. Course work leading to certification in occupational orientation, vocational guidance and vocational administration or supervision is also available through the department.

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: Ed.Ad. 610, Ed.Ad. 625, Ed.Ad. 626, Ed.Ad. 655, Ed.C.I. 601, Ed.C.I. 606, Ed.C.I. 649, E.Psy. 669, E.Psy. 670, I.Ed. 604, Id.Ed. 645 and Sa.Ed. 624.

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.

EDUCATIONAL TECHNOLOGY

Educational technology is designed as a supporting field for doctoral and master's students who are majoring in other disciplines and as a major field for students who are seeking a master of education degree in educational technology. The program stresses a systems approach to education and communication with a focus on the uses of current technologies, particularly computers and related applications. 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.

(Ed.Tc.)

611. 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.

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.

615. Selection and Evaluation of Learning Resources. (3-0). Credit 3. Selection of book and non-book learning resource materials for specific needs or for general collections. Use of basic sources of information on commercially prepared materials with emphasis in the student's area of specialization.

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.

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, color 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 non-linear CAI programs.

681. Seminar. (1-0). Credit 1. Problems pertinent to learning resources specialists, school librarians, classroom teachers, audiovisual specialists and school administrators and supervisors. Recent developments and research in different areas.

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.

INDUSTRIAL EDUCATION

Graduate programs and courses in industrial 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.

(I.Ed.)

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 and vocational education in the U.S.

603. Supervision of Vocational and Industrial Education. (3-0). Credit 3. Problems of supervisors of programs in industrial arts 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. (2-3). Credit 3. Developing programs in industrial arts. Design and organizational strategies for teaching these programs.

616. Methods of Teaching Industrial Education. (3-0). Credit 3. Selection and use of appropriate instructional strategies in industrial 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

Courses that are generic to all programs in the department are listed under the I.V.Ed. prefix and may be used on degree options in each program area.

(I.V.Ed.)

627. Research and Development in Technical Education. (3-0). Credit 3. Methods of conducting research programs in industrial, vocational and technical education.

680. Proseminar. (1-0). Credit 1. Major concepts, principles and issues in education drawn and analyzed from various contributing and theoretical bases. Critical new developments incorporated as they occur. May be repeated for credit. Prerequisite: Approval of instructor.

681. Seminar. (1-0). Credit 1. Reports and discussion of current research, contemporary trends and professional issues in industrial 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 education teacher, supervisor, administrator or researcher. Selected educational or industrial settings appropriate to the student's professional objectives will be used. Prerequisite: Approval of chairman 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 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 and vocational education. Prerequisite: I.V.Ed. 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

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.

(Sa.Ed.)

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: Sa.Ed. 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: Sa.Ed. 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.

VOCATIONAL EDUCATION

The program in vocational education leads to the master of education, doctor of education or doctor of philosophy degrees. Among the many program emphases which students may select as part of their programs are vocational development, postsecondary vocational education, international vocational education, vocational special needs and vocational education evaluation and research. Either as part of or separate from the degree programs, a student may work on the requirements for Texas certification in occupational orientation, vocational counseling and vocational administration/supervision.

(Vo.Ed.)

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.

INTERDISCIPLINARY EDUCATION

P. T. Beatty*, G. B. Chisolm*, G. J. Conti*, R. A. Fellenz*, G. Garcia, Jr.*, D. F. Seaman* (Coordinator), B. N. Stone‡

*Graduate Advisor

‡Faculty from other departments in the College of Education and from departments in the College of Agriculture 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 area of adult and extension education.

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 and extension eduction, adult education research personnel, and administrators for youth and human service agencies.

Classes are also taught which have college-wide and university-wide appeal. These include courses in research methodology and in grantsmanship.

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 in educational planning, research, and evaluation is available to all doctoral students in the College of Education. Such study is designed to prepare students to assume positions as research and development administrators, educational policy analysts, evaluation specialists, educational planners, systems analysts, curriculum coordinators and research professors. This area of specialization includes required core courses and additional electives to be designated by the student's department.

(Id.Ed.)

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.

637. Large Group Instruction for Adults. (3-0). Credit 3. Theories and practices in the planning, promotion and management of large group activities for purposes of adult and extension education. Prerequisite: Id.Ed. 642 or approval of instructor.

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.

650. History and Philosophy of Cooperative Extension. (3-0). Credit 3. Philosophical bases for and historical development of cooperative extension education in agriculture, home economics and 4-H.

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.

660. Community Development Education. (3-0). Credit 3. Preparation in the area of community development; role of education; social, economic and political aspects.

661. Management of Family Resources. (3-0). Credit 3. Principles of management of financial and other family resources. Consumer decision-making and development of educational programs in family resource management.

662. Contemporary Concepts in Housing Education. (3-0). Credit 3. Contemporary concepts in housing which are necessary for planning, implementing and evaluating educational programs in housing.

664. Volunteer Staff Development. (3-0). Credit 3. Principles of volunteer staff development and use in adult and youth education programs.

670. Mathematical Models in Educational Policy Analysis. (3-0). Credit 3. Development and appraisal of educational policy research designs and institutional analyses. Validity and information value of mathematical models applied in the study of selected educational policy issues; impact of court orders on teacher assignments, student achievement and resource allocation patterns. Prerequisites: Stat. 652 and E.Psy. 637 or equivalent.

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.

680. Proseminar. (1-0). Credit 1. Structured seminar on major concepts, principles and issues in education drawn and analyzed from various contributing theoretical and research bases. Critical new developments incorporated as they occur. Required of all Ed.D. students. May be repeated for credit. Prerequisite: Approval of instructor.

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.

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. Prerequisite: Approval of student's advisory 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 major advisor.

INTERDISCIPLINARY ENGINEERING

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 specialization under interdisciplinary engineering include mechanics and materials and systems engineering. Other areas of emphasis to cross disciplinary boundaries may be tailored to suit a student's desires subject to Graduate College regulations and the approval of the student's committee. Students interested in this program should contact the dean of the College of Engineering, Engineering Research Center.

(Itd.E.)

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

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 base for an area of specialization wherein graduate students can 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.

(M.M.)

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: M.M. 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.

613. Principles of Composite Materials. (3-0). Credit 3. Atomic, molecular, micro macrostructure with respect to physical and mechanical properties of composite materials. Plas tic, metallic and ceramic matrices reinforced with continuous and discontinuous fibers, whisker and particulates. Mechanical and chemical interactions, failure modes, interface, fabrication tech niques and structural design concepts. Prerequisite: Approval of instructor.

618. Designing with Composites. (2-3). Credit 3. Application of composite materials princi ples to the design of composite structures. Designers from industry will participate directly t provide instruction on current design methods. Design projects assigned to provide practica experience with design procedures. Prerequisites: M.M. 613 and approval of instructor.

620. Processing and Testing of Composite Materials. (2-3). Credit 3. Experiments demon strating the processing, fabrication and curing, and testing of composite materials including typi cal matrix resins. Acceptance specifications and tests for raw materials and their influence on th finished product. Variables governing the cure cycle. Destructive and non-destructive tests t 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 plate of various shapes and support conditions, bending of anisotropic plates. Plates under combine lateral loads and in-plane forces. Large deflection thin plate theory, theory of shells, stability o plates and shells. Prerequisite: Math. 601 or registration therein.

636. Theory of Thermal Stresses. (3-0). Credit 3. Heat conduction, thermoelasticity an thermoinelasticity as related to thermal stresses. Prerequisites: M.M. 601; approval of instructo

640. Theory of Shells. (3-0). Credit 3. Continuation of study of theory of shells introduce in M.M. 633. Limited to study of linear shell theory. Equations formulated using Lame's sur face parameters. Membrane analysis, bending analysis and shallow shell theory. Prerequisites M.M. 633.

641. Plasticity Theory. (3-0). Credit 3. Theory of plastic yield and flow of two and three dimensional bodies. Classical plasticity theories, unifies viscoplastic theories, numerical consider ations. Applications and comparisons of theory to experiment. Prerequisite: Math. 601 o registration therein.

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 analy sis; three-dimensional stress analysis; isoparametric finite elements; recent developments; finit element computer program project; use of several finite element computer programs to solv typical structural problems. Prerequisite: M.M. 467 or equivalent; or approval of instructor.

648. Nonlinear Finite Element Methods in Structural Mechanics. (3-0). Credit 3. Tenso definitions of stress and strain, finite strain, geometric and material nonlinearities; development o nonlinear finite element equations from virtual work; total and updated Lagrangian formulations solution methods for nonlinear equations; computational considerations; applications using exist ing computer programs. Prerequisite: M.M. 647 or equivalent.

650. Dynamic Fluid-Solid Interactions. (3-0). Credit 3. Dynamic interaction between fluic and solid systems with applications to space vehicles, nuclear reactors, heat exchangers an structures in general. Hydroelasticity, hydrostatic divergence, flow induced vibrations, instabilit 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 mechan ical property characterization methods, time-temperature equivalence, multiaxial stress-strai equations. Viscoelastic stress analysis: the correspondence principle, approximate methods o 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 linea 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 mechanic and materials. May be repeated for credit. Prerequisite: Approval of instructor.

SYSTEMS ENGINEERING

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, Engineering Research Center.

(Sy.En.)

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 projects submitted by several industrial firms. 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 Sy.En. 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.

625. Engineering Entrepreneurship. (3-0). Credit 3. Processes of an engineer taking technological innovation from conception to implementation. Processes are examined in the environments of a new business venture, an existing corporation and a government agency. Prerequisite: Sy.En. 620.

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.

JOURNALISM

(See Communications)

DEPARTMENT OF LANDSCAPE ARCHITECTURE

D. B. Austin, F. Klatt, Jr., H. C. Landphair, L. L. Marshall* (Head), J. L. Motloch, M. D. Murphy

*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 not found in daily practice. Issues dealing with human settlements and natural resource management and development are emphasized as separate specializations in response to the profession's leadership potentials. Students from a variety of undergraduate disciplines are encouraged to undertake individualized investigative efforts and to expand the profession's dedication to the natural and built environment. 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 thesis. Prerequisite: Doctoral classification.

692. Professional Study. Credit 1 or more each semester. Approved professional study or project undertaken as the terminal requirement for the doctor of environmental design degree. Preparation of a record of study summarizing rationale, procedure and results of the completed project. Prerequisite: Approval of committee chairman.

LINGUISTICS

(See English)

DEPARTMENT OF MANAGEMENT

M. A. Abelson, R. Albanese**, T. S. Bateman, B. D. Baysinger, L. Bierman, H. N. Butler, H. Chamberlain, R. L. Daft, G. R. Ferris, C. D. Fisher, R. W. Griffin*, D. Hellriegel, G. R. Jones, G. D. Keim, W. H. Mobley, M. W. Pustay, J. I. Reynolds, G. H. Rice, Jr., A. H. Ringleb, L. F. Schoenfeldt (Head), A. H. Sheer, A. W. Smith, D. D. Van Fleet, R. W. Woodman, S. A. Youngblood, A. Zardkoohi, C. P. Zeithaml

*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 48 credit hours of which 12 credit hours may be taken in the department. Areas of course work include personnel and industrial relations, 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 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. (4-0). Credit 4. 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. 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.

615. Environmental Law and Policy. (3-0). Credit 3. Legal problems and mechanisms for maintaining the environment; common law and federal and state statutory law. Governmental policies and laws for controlling air, water, solid waste and noise pollution. Prerequisite: Graduate classification.

620. Personnel. (3-0). Credit 3. Practices and problems in the acquisition, maintenance, development and use of personnel; human resource planning, recruitment, selection, training and management development, compensation, performance evaluation and labor relations. General management, rather than a technician's, point of view. Prerequisite: Mgmt. 655 or equivalent.

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. Prerequisite: Mgmt. 620 or equivalent.

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. (2-0). Credit 2. 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.

632. Organization Design and Theory. (2-0). Credit 2. 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.

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 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. 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. Cross-listed with I.En. 603.

652. Arbitration Procedures in Work Practices. (3-0). Credit 3. Cross-listed with I.En. 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.

656. Due Process of Law and Administrative Procedures. (3-0). Credit 3. Cross-listed with Pol.S. 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: 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. 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. 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, C. M. Futrell, S. M. Gillespie, L. G. Gresham, R. T. Hise**, J. H. Leigh, G. H. Lucas, Jr., S. W. McDaniel, J. U. McNeal, A. Parasuraman, W. M. Pride* (Interim Head), D. H. Robertson, P. Varadarajan, V. A. Zeithaml

*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 48 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 de signed to prepare students for careers in research and teaching as well as specialize staff positions in public and private organizations.

Additional information, including specific departmental requirements, may be ob tained by contacting the department or the office of the dean, College of Business Ad ministration.

(Mktg.)

649. Survey of Marketing. (3-0). Credit 3. Marketing concepts and functions from the point c view of the company and the economy.

650. Analyzing Consumer Behavior. (3-0). Credit 3. Theoretical and empirical material o 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 rela tions and customer service. Prerequisites: Mktg. 649 or equivalent.

656. Marketing Communications: Non-Personal. (3-0). Credit 3. Communication proc esses, diffusion of innovation and promotion activities: advertising, packaging, sales promotio and publicity. Prerequisite: Mktg. 649 or equivalent.

665. Research for Marketing Decisions. (3-0). Credit 3. Methodology related to problems i marketing decision-making; primary and secondary research methodology and analytical tech niques for measuring consumer attitudes, advertising effectiveness, etc. Prerequisites: Mktg. 64 or equivalent, and a basic statistics course.

671. Product Innovation. (3-0). Credit 3. Understanding of consumer needs and translatin them into new products and services whose design and presentation convey satisfaction of thes needs. Prerequisite: Mktg. 649 or equivalent.

673. Service and Public Marketing. (3-0). Credit 3. Marketing concepts and strategy a applied to professional and public organizations such as health and public services, and educa tional, political and charitable organizations.

675. Marketing Management. (4-0). Credit 4. Marketing management as it relates to overa organization goals. Marketing concepts and functions integrated with other organizational func tions, tactics and strategies. Prerequisites: Graduate classification in business administration.

677. Multinational Marketing Management. (3-0). Credit 3. Theoretical and empirical mate rials on multinational marketing; nature and justification of international trade, analysis of enviror ments faced by multinational firms and formulation of multinational marketing strateg Prerequisite: Mktg. 649 or equivalent.

680. Seminar in Buyer Behavior. (3-0). Credit 3. Detailed examination of the literature i consumer and industrial buyer behavior with emphasis on conceptual and empirical issues; crit cal analysis of buyer behavior theory. Prerequisite: Mktg. 650 or equivalent.

681. Seminar. (1-0). Credit 1 each semester. Critical examination of subject matter presente in current periodicals, recent monographs and bulletins, in field of marketing.

682. Seminar in Strategic Market Planning. (3-0). Credit 3. Marketing aspects of strateg formulation; the market phenomena that are foundations of strategy, models for strategic bus ness unit and corporate strategy formulation, and organizational implications of the strategi market planning process. Prerequisites: Mktg. 649 or equivalent and doctoral classification.

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

688. Doctoral Seminar. (3-0). Credit 3. Historical development of the conceptual framewor of marketing theory and practices; analysis of current research and controversial issues in th field. 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 marketin May be repeated for credit.

690. Theory of Research in Marketing. (3-0). Credit 3. Design of research in the variou subfields of marketing and the evaluation of research results using examples from the currer research literature. May be repeated for credit. Prerequisite: Graduate classification in marketin

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

DEPARTMENT OF MATHEMATICS

O. G. Aberth, G. D. Allen, K. T. Andrews, I. Bakelman, D. L. Barrow, P. W. Bates, G. A. Battle III, G. R. Blakley, H. P. Boas, A. Boggess, J. R. Boone, I. Borosh, J. D. Bryant, C. K. Chui, M. K. Farris, M. E. Flahive, P. Flinn, S. A. Fulling, S. C. Geller, E. Giné, L. F. Guseman, Jr.*, R. A. Gustafson, D. J. Hartfiel, J. P. Henderson, D. A. Hensley, A. M. Hobbs, W. B. Johnson, T. R. Kiffe, H. E. Lacey (Head), D. R. Lewis, M. B. Marcus, C. J. Maxson, C. A. Meadows, S. C. Milne, F. J. Narcowich, N. W. Naugle, W. L. Perry, M. S. Pilant, J. T. Pitts, H. W. Pu, G. B. Purdy, M. H. Rahe, W. Rundell, N. A. Sato, L. L. Schumaker, M.-C. Shaw, D. S. Shucker, K. C. Smith, P. D. Smith, R. R. Smith, M. J. Stecher*, P. F. Stiller, A. H. Stroud, S. D. Taliaferro, L. B. Treybig, J. R. Walton*, J. D. Ward, D. P. Williams, P. B. Yasskin, 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 Math. 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 Math. 311, 312, and 407.

606. Theory of Probability. (4-0). Credit 4. Lebesgue measure and integration, abstract measure and integration, various convergence concepts, random variables, expectation, independence and conditional expectations. 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.

615. Vector Spaces and Matrices. (3-0). Credit 3. Vector spaces, determinants, matrix algebra, similarity relation and unitary similarity relation, applications. Prerequisite: Math. 304 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.

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.

629. Mathematics for Managerial, Social, and Natural Sciences. (3-0). Credit 3. Topics in differential and integral calculus; inequalities in two variables; extremum problems and linear programming; matrices and linear systems; least square approximation; applications to problems in social, managerial and natural sciences. Prerequisites: Graduate classification; 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. Theory of function and sequence spaces and their topologies; measure and integration, summability and series. Prerequisite: Math. 409-410 or equivalent.

642. Analysis for Applications III. (4-0). Credit 4. Further topics in the theory of function and sequence spaces; duality and representations; integral transform methods with emphasis on L^p. Prerequisite: Math. 641.

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.

661. Calculus of Finite Differences. (3-0). Credit 3. Introduction to difference equations, finite element analysis and splines. Prerequisite: Approval of instructor.

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 repeated 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, K. Annamalai, D. N. Bingham, W. L. Bradley, D. E. Bray, J. A. Caton, D. W. Childs, J. K. H. Chou, M. A. Colaluca, L. R. Cornwell, J. J. Engblom, L. S. Fletcher, C. H. Gerhold, R. E. Goforth, R. B. Griffin, J.-C. Han, W. M. Heffington, M. Henriksen, R. E. Holmes, C. L. Hough, Jr., C. F. Kettleborough*, T. J. Kozik, T. R. Lalk, S. C. Lau, M. McDermott, O. Masory, B. W. Mooring, G. L. Morrison, W. E. Murphy, S. T. Noah, O. O. Ochoa, D. L. O'Neal, R. H. Page, J. V. Perry, Jr., J. G. Raczkowski, D. L. Rhode, H. H. Richardson, H. R. Thornton, W. D. Turner, J. M. Vance, 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, corrosion, solar energy and wind tunnel studies. In addition, new research programs have begun in manufacturing processes, nondestructive testing, computer-aided design, manufacturing and plastics engineering.

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 dynamics.

(M.E.)

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: M.E. 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.

612. Mechanics of Robot Manipulators. (3-0). Credit 3. Kinematics, dynamics and control of industrial robot manipulators. Prerequisites: M.E. 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, M.E. 213.

15. 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: M.E. 328 or equivalent.

17. 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, M.E. 213.

20. Experimental Stress Analysis. (2-3). Credit 3. Stress and strain at a point. Theory of photoelasticity and its application to stress analysis. Principles of birefringent coating, moire fringe patterns, stress coat, strain gages and their application. Basic techniques of experimental stress analysis and the related equipment.

21. 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.

22. 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: M.E. 344.

23. Micromechanics of Fatigue and Fracture in Alloys. (3-0). Credit 3. Micromechanics and macromechanics of fracture in metals and alloys with emphasis on microstructural aspects of fracture including cleavage, intergranular fracture and void coalescence; time dependent stable crack growth including stress corrosion cracking, fatigue and intergranular creep crack growth; elastic-plastic fracture mechanics with design applications, fracture mechanics testing. Prerequisite: M.E. 340 or equivalent.

24. 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.

25. Experimental Techniques in Metallurgy. (3-3). Credit 4. Basic theory and application of various experimental techniques in the study of metals and alloys including X-ray diffraction, transmission electron microscopy, scanning electron microscopy, electron microprobe analysis; includes practice demonstrations and projects. Prerequisite: M.E. 340 or equivalent.

26. 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; M.E. 344 or equivalent.

27. 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: C.S. 458 or equivalent; Math. 601 or registration therein; M.E. 461.

28. 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; M.E. 461.

29. 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; M.E. 461.

30. 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.

32. 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: M.E. 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: M.E. 459 or 613.

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; M.E. 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; M.E. 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: M.E. 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.

650. Random Vibration. (3-0). Credit 3. Vibrations of mechanical systems and structures excited by random loadings. Stationary and ergodic processes; probability, correlation and spectral density functions. Finite-degree-of-freedom and continuous systems; point and distributed loadings; first passage and fatigue failures. Data analysis techniques; typical excitation environments; environmental simulation testing; statistical energy method. Prerequisites: M.E. 459.

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: M.E. 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: M.E. 460, Ch.E. 428, Ch.E. 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; M.E. 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: M.E. 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: M.E. 328 and 461 or approval of instructor.

665. Application of Energy Management. (3-0). Credit 3. Continuation of M.E. 662 and M.E. 664. Case studies by students of energy conservation opportunities using energy audits and building load computer simulation. Prerequisites: M.E. 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: M.E. 355 or M.E. 411, and C.S. 202.

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: M.E. 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: M.E. 340 or equivalent.

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 M.M. 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.

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.

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

Selected courses within the College of Medicine may be taken for graduate credit. Only students admitted to, and in good standing in, the Graduate College of Texas A&M University will be considered for admission to these courses. Facility and laboratory equipment restraints and the requirements of the professional students in the college will result in a limitation on the number of graduate students who can be enrolled in each course. Graduate students seeking admission to these courses must have the approval of their faculty advisor, the head of the department in the College of Medicine administering the course and approval by the Dean of Medicine.

Applicants should also be advised that the College of Medicine courses are presented by quarters rather than by semesters, thus, advanced planning on the part of the graduate student is required if he (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.

The specific courses approved for graduate credit are:

Department of Anatomy (M.A.)

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 (M.Bch.)

911. Medical Biochemistry I: Intermediary Metabolism. (3-3). Credit 4. Biochemical basis of disease. Laboratory consists of related clinical chemistry tests. Prerequisite: Admission to medical curriculum or approval of department head.

912. Medical Biochemistry II: Macromolecules, Molecular Biology and Molecular Genetics. (3-2). Credit 4. Biochemical basis of disease continued. Laboratory consists of related clinical chemistry tests. Prerequisite: Admission to medical curriculum or approval of department head.

913. Medical Genetics. (2-2). 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: M.Bch. 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 (M.M.I.)

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: M.M.I. 923; M.A. 911.

985. Problems. Credit 1 or more. Directed individual study of advanced topics in microbiology and immunology. Prerequisites: M.M.I. 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: M.M.I. 923, 924 and approval of department head.

Department of Medical Pharmacology and Toxicology (M.Phm.)

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 M.Phy. 901, 902; M.A. 922; M.Bch. 911, 912.

925. Medical Pharmacology II. Credit 4. Continuation of M.Phm. 924; neuropsychopharmacology, chemotherapy and toxicology. Prerequisite: M.Ph. 924.

985. Problems. Credit 1 or more. Research in specialized areas of pharmacology. Prerequisites: M.Phm. 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 (M.Phy.)

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: M.Phy. 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: M.Phy. 901, 902 and approval of department head.

991. Research. Credit 1 or more. Original investigation in specific areas of physiology. Prerequisites: M.Phy. 901, 902 and approval of department head.

Department of Pathology and Laboratory Medicine (M.Pa.)

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: M.Pa. 923 or approval of department head.

925. Human Pathology III. Credit 4. Continuation of M.Pa. 923 and 924. Prerequisite: M.Pa. 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, W. K. Henry*, G. L. Huebner, Jr., J. P. McGuirk, R. C. Runnels, J. R. Scoggins (Head), A. H. Thompson, T. S. Yuen

*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, mesoscale and air pollution meteorology, 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, 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.

(Met.)

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: Met. 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: Met. 425 or equivalent and approval of instructor.

636. Dynamic Meteorology. (3-0). Credit 3. General circulation; stratospheric dynamics; tropical systems. Prerequisite: Met. 435.

637. Numerical Weather Prediction. (3-0). Credit 3. Numerical solution of meteorological equations, time and space differencing, non-linear stability, spectral approach. Prerequisite: Met. 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; select topics of current interest. Prerequisite: Met. 336.

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 intereactions. Prerequisites: Met. 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: Met. 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: Met. 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: Met. 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: Met. 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 Met. 685. Prerequisite: Met. 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; Met. 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: Met. 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: Met. 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.

DEPARTMENT OF MODERN LANGUAGES

C. C. Christian, Jr.*, L. F. Costa (Interim Head), N. J. Dyer, A. M. Elmquist, W. Koepke, B. L. Lewis, H. W. Puppe, K. C. Richards, L. Stavenhagen

*Graduate Advisor

The Department of Modern 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 the Graduate College 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.

RUSSIAN
(Russ.)

685. Problems. Credit 1 to 4 each semester. Directed individual study of selected problems in the field of Russian. 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.

DEPARTMENT OF NUCLEAR ENGINEERING

F. R. Best*, C. A. Erdman* (Head), R. R. Hart*, C. E. Lee*, M. E. McLain*, T. A. Parish*, K. L. Peddicord*, J. W. Poston*, G. A. Schlapper*, R. S. Wick*

*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, reactor safety and design, fusion engineering, reactor kinetics and controls, space reactors and most areas of health physics.

The facilities available for instructional and research purposes include a well-equipped radiation measurements laboratory, a sub-critical reactor laboratory, AMDAHL 470 V/6 and 470 V/7B digital computers, a multiuser department microcomputer facility, a radiochemistry laboratory, a thermal hydraulics laboratory, a low power nuclear reactor, a Cockcroft-Walton pulsed accelerator, and a large research reactor located at the Texas A&M University Nuclear Science Center. An 88-inch cyclotron is available for research in nuclear physics and engineering.

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 is available at the master's level.

This area of specialized study in the Department of Nuclear Engineering is based strongly on the fundamental aspects of radiation effects on matter. 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 nuclear engineering.

(N.E.)

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: N.E. 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. Prerequisite: N.E. 601.

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: N.E. 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, N.E. 202 or equivalent; B.S. in engineering or physical sciences.

606. Reactor Experimentation. (2-3). Credit 3. Extension of N.E. 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: N.E. 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, N.E. 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: N.E. 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: N.E. 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: N.E. 602 or registration therein, N.E. 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, N.E. 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. Rigourous methods of analysis applied to computation of biological radiation dose and dose rates from various sources and geometries. Radiation effects on physical systems. Prerequisite: N.E. 409.

618. Nuclear Control Systems. (3-0). Credit 3. Reactor kinetics and fundamentals of servocontrol developed and applied to nuclear reactors. Safety aspects of reactor control and operational problems. Prerequisite: N.E. 601 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: M.E. 323 or 327; N.E. 601 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; M.E. 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; N.E. 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; N.E. 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: N.E. 429, N.E. 602 or equivalent.

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: N.E. 612, 613.

680. Practical Applications of Radiological Safety II. (1-6). Credit 3. Continuation of N.E. 679 reaching point where student can design and conduct radiation surveillance operations independently, with no immediate supervision. Prerequisite: N.E. 679.

681. Seminar. (1-0). Credit 1. Special topics in nuclear engineering not covered by form course work. Whenever possible, guest lecturers will discuss topics which they have persona investigated. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Offered to enable students to undertake ar complete limited investigations not within their thesis research and not covered by any oth courses in curriculum. Prerequisite: Graduate classification.

689. Special Topics in . . . Credit 1 to 4. Selected topics in an identified area of nucle 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, L. M. Canfield-Sander, C. E. Coppock, C. R. Cr ger, W. C. Ellis, L. W. Greene, E. D. Harris, D. P. Hutcheson, D. A. Knabe, K. S. Kuben H. O. Kunkel, W. A. Landmann, D. N. McMurray, T. W. Odom, G. D. Potter, J. M. Pre cott, E. H. Robinson, E. G. Sander, G. T. Schelling, G. C. Smith, S. B. Smith, E. M. Su weeks, T. D. Tanksley, Jr., R. D. Wood

The graduate programs in nutrition allow emphases in animal, human and fund mental nutritional sciences. They include biochemical and physiological studies that a concerned with the interaction and metabolism of nutrients and the availability of nut ents from foods. Studies in animal nutrition may be related to animal agriculture ar aquaculture or may be fundamental in nature. Research also may include the cultur and social aspects of nutrition.

Participating in the M.S. and Ph.D. degree programs are the Departments of Anim Science, Poultry Science, and Biochemistry and Biophysics. Contributory courses a offered in the Departments of Veterinary Pathology and Wildlife and Fisheries Science

(Nutr.)

640. Biomineralization in Animals. (3-0). Credit 3. Factors involved in the process biomineralization; role of nutrients, physiological processes and environment in normal and a normal biomineralization. Prerequisites: P.S. 411 or An.Sc. 303; Bich. 410 or 603.

641. Nutritional Mechanisms and Metabolic Regulation in Man. (3-0). Credit 3. Mech nisms of nutrient digestion, absorption, transport, degradation and intracellular metabolic regul tion at the molecular level. Mechanisms in the normal and the diseased state. Prerequisites: Bic 411 or 604. Cross-listed with Bich. 641.

681. Seminar. (1-0). Credit 1. Current developments in the field of human nutrition. Review current literature and oral presentation of scientific papers on selected nutrition topics. Prereq site: Graduate classification.

684. Professional Internship. Credit 1 to 4. Experience in application of formal training applied nutrition under supervision of nutritionists, dietitians and faculty member. Student w investigate matter of mutual interest and report results in a professional paper approved by th graduate committee. Prerequisite: Graduate classification.

685. Problems. Credit 1 to 4 each semester. Human nutrition problems and procedure Problems assigned according to experience, interest and needs of individual student. Prereq site: Approval of instructor prior to registration.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of human nut tion. May be repeated for credit. Prerequisites: Graduate classification and approval of instruct

691. Research. Credit 1 or more each semester. Investigations leading to thesis or dissert tion in various areas of human nutrition. Prerequisite: Graduate classification.

DEPARTMENT OF OCEANOGRAPHY

. Berner, Jr., D. C. Biggs, T. J. Bright, D. A. Brooks, J. M. Brooks, W. R. Bryant, J. D. ochrane, R. Darnell*, S. Z. El-Sayed, D. A. Fahlquist, R. R. Fay, G. A. Fryxell, L. E. arrison, S. Gartner, E. E. Hofmann, T. Ichiye, L. M. Jeffrey, M. C. Kennicutt, Jr., J. M. linck*, J. D. McEachran, W. J. Merrell, J. W. Morse, W. D. Nowlin, Jr., E. N. Powell, . J. Presley, P. D. Rabinowitz, R. O. Reid (Head), R. Rezak, W. W. Sager*, D. R. Schink, . R. Schwarz, M. R. Scott*, T. K. Treadwell, Jr., A. C. Vastano, J. H. Wormuth

Graduate Advisor

egrees. Degrees of master of science and doctor of philosophy are offered in ceanography.

ceanography. Oceanography is the interdisciplinary science that focuses on the cean, its contents and its boundaries. Whereas typical graduate programs lead to pro-ressively greater amounts of specialization, oceanography as an interdisciplinary field dmits graduates of specialized areas such as biology, chemistry, geology, mathemat-s, physics or engineering and initially generalizes and broadens their education with a ore of required courses. These core courses include the four specializations of the ceanography program — biological, chemical, geological/geophysical and physical ceanography — as well as a techniques course and a seminar covering the state of the cience. After this exposure to the interdisciplinary nature of oceanography, the gradu-te student refocuses in his or her particular subject area to pursue research at the eading edge of the science.

Required prerequisites are the equivalent of a B.S. degree in one of the basic fields ientioned above and basic courses in each of the other areas. All students are expected) have had mathematics through integral calculus, at least one year each of physics and hemistry, and at least one survey course in biology and geology. These are in addition to ie 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 n ability to apply basic science to the marine environment. This capability requires a ombination of principles and methods and a certain body of knowledge unique to ceanography; a student of oceanography must become conversant in all of the marine ciences.

acilities and Participation in Research. Facilities include office, laboratory and lassroom space in the 15-story Oceanography and Meteorology Building on the Col-ge Station campus; space at the Texas A&M University Research and Extension Cen-er; office, shop and dock facilities on Pelican Island in Galveston, Texas; the R/V *Gyre*, a 79-foot oceangoing research vessel; the R/V *Deborah Suzanne*, a 47-foot shelf and oastal research vessel; the DRV *Diaphus*, a 2-person, 1200-foot depth research sub-ersible; and a large research equipment inventory. Graduate students usually take n active part in research grants and contracts awarded to individual professors and esearch teams by federal and state agencies, industry and private foundations. Texas &M University and the University of Texas recently signed an agreement creating a joint iarine operations facility. This agreement provides for joint use of vessels and ship use cheduling through a single marine operations office.

equired Courses. Ocn. 602, 608, 620, 630 and 640 and two hours of oceanogra-hy seminar (Ocn. 681) are required of all graduate students who are candidates for 1.S. and Ph.D. degrees. A reading knowledge of one modern foreign language is re-uired of all Ph.D. candidates. Further information is available from the department.

(Ocn.)

600. Survey of Oceanography. (3-0). Credit 3. General survey of the scientific framework (oceanographic study. Applications of ocean research to social and economic problems; interrel tions between the ocean disciplines and other fields of study. Prerequisite: Approval of instructc

602. Ocean Research and Operational Techniques. (1-5). Credit 3. Technical, operation and legal aspects of sea-going research operations. Planning and executing ocean researc operations. Practice in techniques and equipment regularly used aboard ships; familiarizatic with acquisition and processing of data. Prerequisite: Approval of instructor.

604. Biological Oceanography Cruise. Credit 2. Specialized experience in research metl ods and analysis in biological oceanography via preparation for and participation in a researc cruise of at least two weeks duration under the supervision of a Texas A&M oceanography facul member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. canc dates. Prerequisite: Approval of instructor.

605. Chemical Oceanography Cruise. Credit 2. Specialized experience in research metl ods and analysis in chemical oceanography via preparation for and participation in a researc cruise of at least two weeks duration under the supervision of a Texas A&M oceanography facul member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. canc dates. Prerequisite: Approval of instructor.

606. Geological Oceanography Cruise. Credit 2. Specialized experience in research metl ods and analysis in geological oceanography via preparation for and participation in a researc cruise of at least two weeks duration under the supervision of a Texas A&M oceanography facul member. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. canc dates. Prerequisite: Approval of instructor.

607. Physical Oceanography Cruise. Credit 2. Specialized experience in research methoc and analysis in physical oceanography via preparation for and participation in a research cruis of at least two weeks duration under the supervision of a Texas A&M oceanography faculty men ber. May be taken for credit up to twice for M.S. candidates and four times for Ph.D. candidate Prerequisite: Approval of instructor.

608. Physical Oceanography. (3-2). Credit 4. Observations, instruments; physical propertie of seawater. Property distributions; characteristics of water masses; heat budget. Kinematic gravity, pressure, hydrostatics, stability. Horizontal flow; Coriolis force, geostrophy; friction, win drift; general circulation. Wave motions; tides. Prerequisites: Math. 122 or equivalent; Phys. 21

609. Physical Oceanography. (3-0). Credit 3. Kinematics of fluids, systematic derivation (the equations of motion and continuity; general integral relations; thermodynamic consideratior of seawater; non-equilibrium transfer processes and the second law of thermodynamics. Prere uisites: Math. 601; Met. 435 or Ocn. 608 (concurrently).

611. Theoretical Physical Oceanography. (3-0). Credit 3. Reynolds equations of motio scaling analysis, Ekman layers; application of vorticity equation to ocean circulation; meande and Rossby waves; inertio-gravity waves and other wave phenomena in the ocean includin boundary waves. Prerequisites: Ocn. 608, 609.

612. Elements of Ocean Wave Theory. (3-0). Credit 3. Theories of simple harmonic surfac gravity, capillary and internal waves. Wave propagation, dispersion and energy. Modificatior due to rotation, variable depth and finite amplitude. Prerequisites: Math. 601; Ocn. 608; or ap proval of instructor.

614. Dynamics of the Ocean and Atmosphere. (3-0). Credit 3. Unified linear perturbatic theory of rotating stratified fluids with application to waves in the ocean or atmosphere. Energ considerations, characteristic modes of motion, approximate methods of analysis. Offered i 1984-85 and alternate years thereafter. Prerequisites: Math. 602; Ocn. 611.

617. Theories of Ocean Circulation. (3-0). Credit 3. Theories of wind-driven circulatio Sverdrup solution, frictional and inertial boundary regimes; instabilities, meanders and mesoscal features. Role of stratification, topography and time dependence. Thermohaline circulation. O fered in 1985-86 and alternate years thereafter. Prerequisite: Ocn. 611 or approval of instructc

620. Biological Oceanography. (3-0). Credit 3. Critical analysis of contribution of biologic science to our understanding of sea. Discernible interrelationships between organisms and phys cochemical parameters. Prerequisite: General prerequisites for oceanography.

621. Open-Ocean Physiological Ecology. (2-3). Credit 3. Metabolic adaptations and bi chemical responses exhibited by open-ocean plankton and benthos to high hydrostatic pressur low temperature and oxygen minima stresses. Nutritional ecology and ecological bioenergetic of oligotrophic oceanic systems. Prerequisite: Ocn. 620 or graduate classification in oceanogr phy, 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 1984-85 and alternate years thereafter. Prerequisite: Ocn. 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: Ocn. 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: Ocn. 620 or equivalent.

626. Organic Cycles of the Sea. (3-0). Credit 3. Nature, sources and kinetics of organic materials of the sea. Interrelationships of the physical, chemical and biological aspects presented to provide comprehensive picture of the marine ecosystem as a functional unit. Prerequisite: Approval of instructor.

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 science or approval of instructor.

629. Field Studies on Atlantic Coral Reefs. Credit 2. Three-week field trip to living coral reef in the Gulf of Mexico or the Caribbean. Familiarization with reef zones and fauna. Skin diving ability required. May be repeated once for credit. Prerequisite: Ocn. 628 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. Offered in fall semester each year. 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 1986 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: Ocn. 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 1987 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 1984-85 and alternate years thereafter. Prerequisite: Approval of instructor.

640. Chemical Oceanography. (3-0). Credit 3. Chemical composition and properties of seawater, evaluation of salinity, pH, excess base and carbon dioxide system in sea. Marine nutrients, oxygen and other dissolved gases, organic constituents. Prerequisite: 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 1985-86 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, phosphorus, nitrogen. Offered in spring 1984 and alternate years thereafter. Prerequisite: Ocn. 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. 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. 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: Met. 445 or Ocn. 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: Ocn. 608.

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: Ocn. 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. 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: Ocn. 630.

669. Geology and Geophysics of Passive Continental Margins. (3-0). Credit 3. Marine geological and geophysical observations bordering the world's passive continental margins. Evolution of the passive margin including the tectonics and other processes active during the earliest rift history and subsequent separation of the continents. Prerequisite: Ocn. 630 or approval of instructor.

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: Ocn. 620 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, R. W. Heins, S. A. Holditch, E. R. Hoskins, W. J. Lee*, R. A. Morse*, J. S. Osoba, S. W. Poston, T. G. Rozgonyi, J. E. Russell*, R. A. Startzman, W. D. Von Gonten* (Head), 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 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 specialization 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.

(Pet.E.)

601,602. Drilling and Completing Wells. (3-3). Credit 4 each semester. Problems encountered in drilling, completing and producing of oil and gas wells. Prerequisite: Approval of department head.

603,604. Advanced Reservoir Engineering. (3-3). Credit 4 each semester. Petroleum reservoir engineering; development and use of numerical models for simulating field and well performance. Prerequisite: Approval of department head.

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: Pet.E. 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: Pet.E. 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. Prerequisites: Pet.E. 603, 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: Pet.E. 428, 438.

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: Pet.E. 438 and 448.

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: Pet.E. 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 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. 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

R. Becka, R. W. Burch, M. M. Davenport, C. E. Harris, Jr., L. A. Hickman, H. J. McCann, Jr. (Head), J. J. McDermott, P. B. Thompson

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.

PHYSICAL EDUCATION

(See Health and Physical Education)

DEPARTMENT OF PHYSICS

T. W. Adair III, R. E. Allen, W. H. Bassichis, R. A. Bryan, D. A. Church, R. B. Clark, 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, G. W. Kattawar, R. A. Kenefick, W. P. Kirk, C.-M. Ko, J. A. McIntyre, P. M. McIntyre, T. Meyer, D. G. Naugle*, L. C. Northcliffe, J. M. Parpia, G. N. Plass, J. F. Reading, W. M. Saslow, H. A. Schuessler, P. J. Siemens, R. A. Smith, R. E. Tribble (Head), R. C. Webb, 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, astronomy, 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. 405 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. 416, 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, 416; 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, 416; 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. 428 and 606 or equivalents.

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. 424 or 617, 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.

642. Atomic and Electron Physics. (3-0). Credit 3. Theory of hyperfine structure; atomic and nuclear moments; isotope shift; core polarization atomic beam resonance methods; optical pumping and level crossing; quantum electronics; topics from current literature involving recent theories and experimental methods on stored ions, dilute plasmas and polarized beams. Prerequisite: Phys. 412 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 424 or 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.

646. Intermediate Energy Nuclear Physics. (3-0). Credit 3. Topics of current theoretical and experimental interest; particle-particle scattering, particle-nucleus scattering, symmetries, polarization analysis; multiple scattering, nuclear structure studies and dynamical models. Prerequisite: Phys. 624 or equivalent.

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 424, 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. 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 4 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 repeated for credit. Prerequisites: Phys. 601, 603, 606 and 607 or equivalents.

DEPARTMENT OF PLANT PATHOLOGY AND MICROBIOLOGY

D. N. Appel, A. A. Bell, L. S. Bird, N. E. Borlaug, J. A. Browning (Head), J. Craig, J. W. Dieckert, K. M. El-Zik, R. A. Frederiksen, R. S. Halliwell, J. M. Halloin, C. W. Horne, R. K. Jones, C. M. Kenerley, S. D. Lyda*, C. W. Magill, R. D. Martyn, Jr., M. E. Miller, G. N. Odvody, R. E. Pettit, D. H. Smith, 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

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, ecology of soil-borne pathogens, etiology and epidemiology of plant diseases, nematology, virology, phytotherapeutics and clinical phytopathology.

(Pl.Pa.)

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. Methods in Plant Pathology. (2-6). Credit 4. Standard principles, techniques and equipment used in investigation of plant disease and plant pathogens. Prerequisite: Pl.Pa. 301 and 303 or equivalent.

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: Pl.Pa. 616, undergraduate biochemistry and 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: Pl.Pa. 301 and 303 or equivalent.

620. Plant Viruses. (2-3). Credit 3. Nature and properties of plant viruses and plant virus diseases. Prerequisite: Pl.Pa. 301 and 303 or equivalent.

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: 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: Pl.Pa. 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: Pl.Pa. 301 and 303 or equivalent.*

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. Prerequisite: Biol. 353, Pl.Pa. 301 and 303 or equivalent.

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: Pl.Pa. 301, 303.*

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 Sciences.

685. Problems. Credit 1 to 4 each semester. Individual problems or research not pertaining to thesis or dissertation. Prerequisite: Pl.Pa. 301 and 303 or equivalent.

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, J. S. Boyer, D. D. Briske, C. A. Call, J. T. Cothren, F. T. Davies, Jr., J. W. Dieckert, F. Fong, E. A. Funkhouser, T. C. Hall, W. R. Jordan, J. W. Kelly, S. D. Lyda, G. G. McBee, K. J. McCree, E. L. McWilliams, M. G. Merkle, 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, 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.Agr., 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 their major professor's department.

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.

(P.Phy.)

602. Physiology of Plants. (3-0). Credit 3. Major areas of general plant physiology. Plant functions in terms of current hypotheses. Provides necessary background for more advanced courses in plant physiology. Prerequisite: P.Phy. 313 or equivalent.

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: Chem. 228; P.Phy. 314 or 602.

606. Plant Metabolism II. (3-0). Credit 3. Regulation of plant metabolism, protein synthesis, organelle structure and function, storage molecules and secondary plant metabolites. Prerequisites: Bich. 410, 411 or P.Phy. 605.

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 1985-86 and alternate years thereafter.)

609. Quantitative Plant Physiology. (2-6). Credit 4. Methods employed in various types of physiological investigations and interpretation of results obtained by them. Prerequisite: P.Phy. 314 or 602.

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: P.Phy. 314 or 602.

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: P.Phy. 314 or 602.

613. Plant Growth and Development. (3-0). Credit 3. Mechanisms of the induction of nuclear and organelle genes by light, photoperiod, temperature and stress. Control of the growth and differentiation of plants. Prerequisite: P.Phy. 314 or 602.

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: P.Phy. 314 or 602; Bich. 410, 411 and a biochemistry laboratory course.

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: P.Phy. 314 or 602.

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.

690. Theory of Research in Plant Physiology. (3-0). Credit 3. Research inquiry and discussion of experimental design, theoretical techniques and scientific methodology in conducting scientific research. Recording, evaluation, interpretation and presentation of data. 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

W. E. Benton, R. A. Bernstein, J. R. Bond, B. E. Browne, W. A. Dixon, J. A. Dyer, G. C. Edwards III, G. M. Halter, K. E. Hamm**, R. E. Harmel, E. B. Herzik, D. B. Hill, C. A. Johnson*, M. B. Levy, N. R. Luttbeg, D. C. McCool, K. R. Mladenka, J. L. Payne, J. P. Pelissero, E. B. Portis, K. H. Ro, B. W. Robeck, J. D. Robertson, W. P. Snyder, H. J. Tucker, A. Vedlitz, W. F. West, C. W. Wiggins (Interim Head)

*Graduate Advisor
**M.P.A. Program Coordinator

Graduate study in political science is offered leading to the degrees of master of arts and master of public administration. The curriculum is appropriate (1) for those interested in commencing preparation for teaching and research at the collegiate level, (2) as preparation for a career in the public service, either political or administrative, (3) for teaching at the secondary level, (4) or as preparation for still more advanced work in the discipline. The M.P.A. degree is based upon an interdisciplinary professional curriculum designed to provide broad preparation in public policy and administration for managerial careers in government.

The following paragraphs describe the M.A. degree program in political science. The M.P.A. degree program is described in another section of this catalog.

The courses offered in this degree program permit in-depth study of American politics and political behavior, international and comparative politics, political theory and methodology, public policy and administration, and law and judicial institutions. For still further breadth, or for support in depth of a special interest, a minor outside the department may be undertaken. While not required, such minors are often encouraged.

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 (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; here a comprehensive examination is mandatory.

A minor in political science requires at least nine semester hours; these may be within one area of specialization but must include at least six hours at the 600 level. Minors in other disciplines are subject to the regulations of those disciplines as outlined elsewhere in this announcement. But, whether or not a student undertakes a formal minor, one may, with the concurrence of one's graduate committee, take relevant supporting work outside political science.

Program formulation is unusually flexible within the minimal constraints outlined above. The initiative for selection of a student's graduate committee lies with the student. The committee and the student together design a suitable program.

Prerequisites: While there are no precise course prerequisites for entry into the M.A. degree program in political science, prior work in political science or in one of the following or a combination of them is especially helpful: any of the social sciences, history, philosophy, law or mathematics. In some cases other work may be appropriate. Students without adequate preparation for the graduate program they propose may be required to take prerequisite work in addition to the 30 hours required for a master's degree.

Prospective students uncertain as to prerequisites or opportunities are encouraged to correspond with the graduate advisor prior to entering into the admissions process. On language requirements and other relevant matters see especially the general discussions of the M.A. degree and of financial assistance elsewhere in this announcement.

(Pol.S.)

601. Components of Political Inquiry. (2-2). Credit 3. Research designs, data collection, models and conceptual frameworks as used in the social sciences, especially political science. Required for political science majors.

602. Quantitative Political Analysis. (2-2). Credit 3. Theory, techniques and applications of quantitative analysis in political science. Prerequisite: Six hours of advanced social science or approval of instructor. Required for political science majors.

610. Parties and Group Politics. (3-0). Credit 3. American political process; party system, structure and organization; interest groups, influence and regulation; nominations, campaigns and elections; comparative party systems; the political environment.

614. The American Presidency. (3-0). Credit 3. Office of President of the U. S.; its place in the constitutional and political system. Modern experience and current problems of the office.

615. Legislative Process and Behavior. (3-0). Credit 3. Congress and state legislatures; recent research findings and relevant theoretical frameworks.

616. State Politics and Administration. (3-0). Credit 3. Politics, administration and public policy in the American states; contextual factors, political parties and elections, interest groups, the legislatures, governors, state courts, programs and policy outcomes. Prerequisite: Six hours of advanced social science or approval of instructor.

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.

622. Government and Politics of Asia. (3-0). Credit 3. Comparative analysis of governments and politics in China, India and Japan. Traditional and modern patterns as they affect political behavior, modernization, and foreign and economic policies of each nation. Prerequisite: Six hours of advanced social science or approval of instructor.

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.

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.

636. Politics and Development of the Non-aligned Nations. (3-0). Credit 3. Political issues involved in development and modernization of non-aligned nations.

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.

651. Reading Seminar in Political Theory. (3-0). Credit 3. Directed work on selected problems in political theory. May be repeated for credit.

655. Law and Society. (3-0). Credit 3. The meaning of law, its purpose, functions and history; impact of law on society. Law as a system and a social device central to the governing of society.

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.

657. Judicial Process. (3-0). Credit 3. Power, process and outputs of state and federal courts; behavior of actors in the process.

660. Political Behavior. (3-0). Credit 3. Major approaches to the study of political behavior, personality and politics, political socialization and the social, cultural and economic characteristics of political activists.

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*, J. R. Cain*, C. R. Creger* (Head), J. H. Denton, R. C. Fanguy*, F. A. Gardner*, W. F. Krueger*, D. B. Mellor*, T. W. Odom*

*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 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 science and doctor of philosophy degrees. Faculty expertise exists for study in poult genetics and breeding, poultry nutrition and feeding, avian physiology, environment physiology, reproduction, game bird management, incubation, production and ma agement, poultry processing and marketing, and poultry product development.

(P.S.)

603. Avian Incubation and Embryology. (3-3). Credit 4. Embryonic development of bi eggs under both commercial and experimental incubation conditions. Developmental process are evaluated relative to various environmental and genetic parameters. Prerequisite: Approval instructor.

604. Trends in Poultry Technology and Management. (3-2). Credit 4. Intensive literatu review and in-depth analysis of special topics in poultry science; may include advanced enviro mental physiology, endocrinology and reproduction, birds as models for biomedical researc efficiency economics, management innovations, etc. Summer topics include effective use of pou try in teaching, poultry projects and demonstrations, poultry oriented youth programs, rece advances in the industry, etc. Prerequisites: P.S. 201, 425, or equivalent.

609. Avian Physiology. (3-3). Credit 4. Basic physiological principles pertaining specifica to avian species. Cardiovascular, neural, respiratory, digestive, endocrine and reproductive sy tems. Physiological experiments use various avian species as laboratory animals. Prerequisit Approval of instructor.

611. Poultry Processing and Distribution Technology. (3-2). Credit 4. Poultry and eg composition, mechanisms of poultry and egg quality preservation, effects of storage enviro ments, time and product treatment. Evaluation of commercial methods of product assemb processing, distribution and quality control. Evaluation of physical, microbiological, function and chemical methods of quality determination. Cross-listed with F.S.T. 611.

615. Avian Nutrition. (3-0). Credit 3. Metabolism and nutritional requirements of domest fowl including proteins, carbohydrates, fats, minerals, vitamins and related feed additives. Prere uisites: Chem. 228 or 232; P.S. 411 or approval of instructor.

625. Least-Cost Feed Formulation. (2-2). Credit 3. Theoretical and applied principles ass ciated with least-cost feed formulation, ingredient inventory, farm and feed mill managemer Computer optimization of resources for most efficient least-cost production with applications to domestic farm animals. Applications of micro-computer technology. Prerequisites: P.S. 41 An.Sc. 309.

681. Seminar. (1-0). Credit 1 each semester. Intensive review of literature on feeding, bree ing, incubation, marketing, and management. Development of familiarity with journals, organiz tions, agencies and personnel working on poultry problems. May be repeated as mar semesters as desired. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4. Work-study program, for students interested in master of agriculture degree in avian science. Students expected to prepare a scholarly repc acceptable to graduate committee.

685. Problems. Credit 1 to 6 each semester. Individual problems involving application theory and practice in the various disciplines of poultry science. Prerequisite: Approval of depa ment head.

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

691. Research. Credit 1 or more each semester. Research methods and techniques breeding, nutrition, physiology, marketing, management and products technology. Studen must conduct experiments in one of these fields. Design of experiments, collection, analysis ar presentation of experimental data. Designed for thesis or dissertation credit.

DEPARTMENT OF PSYCHOLOGY

L. T. Benjamin, Jr., B. O. Bergum, A. E. Bourgeois, A. J. Casey, L. B. Christensen, W. Crano, E. S. Davidson, R. B. Evans, D. Fallon, R. J. Foti, J. M. Kern, A. D. LeUne J. LoPiccolo, C. J. Lutes, C. L. Muehlenhard, J. R. Nation, W. S. Rholes*, J. H. Riskin

I. B. Shaw, L. C. Shine II, D. D. Simpson, S. M. Smith, C. M. Stoup, T. B. Ward, P. J. Vellman, W. Wood, S. Worchel

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 specializing in their 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. 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.

(Psy.)

503. 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.

504. Personality and Social Behavior. (3-0). Credit 3. Advanced seminar focusing on special topics; interaction of personality and situational determinants of behavior. Prerequisite: Psy. 412.

505. 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: Psy. 306 and approval of instructor.

506. 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: Psy. 406 or approval of department head.

507. Experimental Psychology. (2-3). Credit 3. Experimental methods; developing a general frame of reference for approaching experimental research problems.

509. 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: Psy. 409.

510. Organizational Psychology. (3-0). Credit 3. Current literature and research in employee motivation, satisfaction, leadership, communication, group conflict and other group processes.

511. 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; Psy. 351 or equivalent or approval of instructor.

512. Behavior Modification. (3-0). Credit 3. Principles of behavior theory and techniques of application to pathological and deviant behaviors. Prerequisite: Psy. 406 or approval of department head.

514. 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. 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.

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 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: Psy. 315; Soc. 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.

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: Psy. 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: Psy. 623, E.Psy. 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; Psy. 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: Psy. 605, Psy. 626, and Psy. 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: Psy. 671 or approval of instructor.

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 repeated for credit. Prerequisite: Psy. 610 or approval of instructor.

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 Psy. 107. Prerequisite: Graduate classification.

DEPARTMENT OF RANGE SCIENCE

S. R. Archer, W. H. Blackburn, R. W. Bovey, D. D. Briske, C. A. Call, A. D. Chamrad, 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. E. Meyer, B. J. Ragsdale, E. J. Rykiel, Jr., J. L. Schuster* (Head), C. J. Scifres, F. E. Smeins, J. W. Stuth, C. A. Taylor, Jr., D. N. Ueckert, L. W. Varner, J. W. Webb, T. G. Welch, L. D. White

*Graduate Advisor

Graduate studies lead to the M.Agr., M.S. and Ph.D. degrees in range science. The M.Agr. degree is a professional (non-research) program directed to advanced training in management of rangeland resources, while the M.S. and Ph.D. degrees place emphasis upon a fundamental background in rangeland resources and supporting disciplines and upon the ability to perform research of high quality.

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. Rangeland areas are available for field study of biosystematics, range animal and plant nutrition, watershed management, range ecology, remote sensing, resource management, and range weed and woody plant control.

Graduate courses are designed to develop the academic skills of individuals and to advance their knowledge in the professional field of range science. 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, economics, soil science and wildlife science. There is no foreign language requirement for the Ph.D. degree in range science.

(R.S.)

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: R.S. 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: Graduate majors and minors in range science. Cross-listed with Ag.Ec. 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: R.N.R. 205 or equivalent.

608. Remote Sensing for Wildland Resource Management. (3-0). Credit 3. Remote sensing for the management of renewable natural resources; state-of-the-art applications to rangeland management, resource assessment and systems analysis in renewable natural resources. Aerial photography, satellite imagery and other remote sensing data products. Prerequisite: Graduate classification.

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: R.N.R. 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, R.S. 417, Stat. 652 or equivalents.

614. Advances in Range Improvement Practices. (3-0). Credit 3. Brush and weed control, revegetation, fertilization, burning and special treatments. Principles and recent advances in improvement practices.*

615. Rangeland Managerial Analysis. (3-0). Credit 3. Ranch management processes in planning, application and control 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: R.S. 314 or approval of department head.*

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.

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.

DEPARTMENT OF RECREATION AND PARKS

D. E. Albrecht, E. G. Carls, J. L. Crompton, R. B. Ditton, D. S. Fesenmaier, J. H. Gramann, E. H. Heath*, L. Hodges*, R. A. Kaiser, L. R. King, A. S. Mills, L. M. Reid (Head), C. S. Van Doren, J. M. Westphal

*Graduate Advisor

Graduate course offerings in the Department of Recreation and Parks are designed to identify and provide scientific solutions to current and possible future problems encountered by administrators, educators and professional practitioners. The focus is upon the total leisure environment and its resource base, employing the most current valid and reliable techniques and methods of research and evaluation. This encompasses fundamental and practical concepts associated with the planning and administration of recreation and park areas and systems including studies in comprehensive recreation resource planning, quality and carrying capacity, user preferences and demand, agency administration and alternative methods for meeting leisure needs.

Graduate study in recreation and parks is by nature highly interdisciplinary. Close cooperative relations exist with a large number of the outstanding graduate-level programs in the University. This affords the student unusual opportunity to structure an individualized and highly relevant degree program in the field of his or her choice. Faculty expertise exists for study in recreational land use planning; travel, tourism and commercial recreation; marine recreation management/development; recreation and park administration; social and behavioral studies; or environmental and cultural interpretation.

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 is designed to emphasize 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. In addition, 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 response to this program has been overwhelming, both in cooperating in the creation of internships, and in employment of graduates having this professional orientation.

The Department of Recreation and Parks no longer requires one or more modern foreign languages as an integral part of all Ph.D. degree programs. The decision regarding the appropriateness of competence in a modern 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.

Courses selected within the department and in supporting fields are designed t serve the individual needs of persons interested in teaching, public service, research c the administration of recreational developments. These courses stress the study of spa tial relationships between humans and the natural environment in various recreation settings in which the primary concern is managerial response to urbanization, to pattern of leisure-time use and to man's critical need of open space.

(R.P.)

601. Recreation and Leisure Concepts. (3-0). Credit 3. History and philosophy of the field recreation and parks; fundamentals of planning, development and management of resource allocated for recreation, parks and tourism purposes. Development of the recreation moveme with broad treatment of the role of recreation and parks in contemporary society.

602. Conceptual Foundations of Recreation and Resource Development. (3-0). Credit Development of contrasting concepts of leisure and recreation in relation to current recreation trends and needs. Contemporary role of recreation in society; implications of leisure-time use an necessary managerial responses. Prerequisite: R.P. 601 or approval of department head.

603. Recreational Organization and Policy. (3-0). Credit 3. Executive leadership in pa departments and recreation agencies; administration of recreation resources to meet huma needs, decision-making and the structure of organizational goals. Prerequisite: Approval of d partment head.

605. Decision-Making in Recreation Administration. (3-0). Credit 3. Political and ec nomic realities associated with policy and decision-making in resource allocation. Using gam simulation techniques as a predictive tool, specific problems are examined and alternati decisions evaluated.

607. Recreation and Park Design. (2-3). Credit 3. Fundamentals of the recreation plannin process; historical perspective and objectives of planning; planning models; major compone analysis including public involvement, resource evaluation, demand analysis, classification sy tems and standards, integral implementation and planning research needs.*

609. Socio-Economic Issues in Outdoor Recreation. (3-0). Credit 3. Socio-econom characteristics impinging on provision of outdoor recreation opportunities in urban and nonurba settings. Implications of economic factors to demand estimation, valuation, costs and repaymer financing, natural resource allocation, public-private sector interactions and policy issues. Prere uisite: Approval of department head.

611. Recreation Systems Planning. (2-3). Credit 3. Components of the tourism-par recreation development system and the concepts of planning resource use at the larger-than-si scale. Physical and program factors important to development for visitor use. Computer tec niques for land assessment. Prerequisite: Approval of department head.

615. Analytical Techniques in Recreation. (3-0). Credit 3. Analysis of current researc instruments and adaptive techniques used in the selection and formulation of research problem Prerequisite: Approval of department head.

622. Recreational Resource Communication. (2-3). Credit 3. Philosophies, concepts an techniques associated with communication and dissemination of information pertaining to use natural resources for recreation.*

636. Travel and Tourism. (3-0). Credit 3. Tourism and recreational travel; origins, prese characteristics and societal impacts; implication of non-business travel in the U.S. and the emer ing importance of international recreation. Prerequisite: Approval of department head.

650. Recreation Resource Development. (3-0). Credit 3. Theory of resource planning an development and of the role and significance of recreation and tourism in the broader enviro mental context; evaluation of relevant current and previous action programs in this country an elsewhere. Prerequisite: R.P. 603 or approval of department head.*

655. Recreation and Sports Law. (3-0). Credit 3. Legal principles affecting sponsors an users of recreation, parks and sports programs; liability concepts in tort, contract, civil rights an property law in program planning, development and management. Prerequisite: R.P. 609 or a proval of instructor. Cross-listed with P.E. 655.

660. Environmental Impact Analysis for Parks and Recreation. (3-0). Credit 3. Analys and critique of contemporary environmental analysis methods in current use; environmental in pact statements. National policies; political, social and legal ramifications as related to recreatic development.

566. 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.

581. 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.

584. 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. Prerequisite: Approval of department head.

585. 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.

589. 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.

590. 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. Prerequisite: Approval of department head.

591. 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, geography, geology, oceanography, range science, recreation and parks and wildlife and fisheries sciences may find these courses applicable to their degree plans, subject to Graduate College regulations and the approval of their graduate committees.

(R.N.R.)

561. 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.

562. 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.

564. 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.

589. 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)

DEPARTMENT OF SOCIOLOGY

B. E. Aguirre, J. P. Alston, J. H. Copp, B. M. Crouch, B. A. Finlay, J. Gaston (Head), W. P. Kuvlesky, W. A. McIntosh, E. Maret, S. H. Murdock, J. S. Picou*, A. Schaffer, R. Schaffer, J. A. Sell, M. Zey-Ferrell

*Graduate Advisor

Graduates from accredited universities who meet the requirements of the Department of Sociology and the Graduate College 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.

Course work in sociology currently stresses social organization; social inequality, demography; sociological theory; social psychology; rural sociology, urban sociology and research methodology. At the Ph.D. level additional specialty areas may be developed with other departments.

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.

(Soc.)

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: Soc. 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: Soc. 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: Soc. 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: Soc. 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: Soc. 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: Soc. 205 or Ed.C.I. 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: Soc. 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: Soc. 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.

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: Soc. 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: Soc. 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: Soc. 622.

635. Sociology of Complex Organizations. (3-0). Credit 3. Comparative structures; contingency models; micro- and macro-theoretical perspectives.

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, W. B. Anderson, E. C. Bashaw, J. B. Beard, A. J. Bockholt, N. E. Borlaug, G. R. Bowers, Jr., J. S. Boyer, R. D. Brigham, K. W. Brown, E. Burnett, F. G. Calhoun, J. M. Chandler, L. E. Clark, B. E. Conrad, J. T. Cothren, J. B. Dixon, J. R. Dunlap, E. F. Eastin, G. W. Evers, F. Fong, P. A. Fryxell, C. J. Gerard, E. C. Gilmore, Jr., V. A. Haby, C. T. Hallmark, G. E. Hart, J. L. Heilman, F. M. Hons, G. L. Horst, L. R. Hossner, L. A. Johnson, W. R. Jordan, R. J. Kohel, R. H. Loeppert, Jr., E. W. Lusas, G. G. McBee, G. N. McCauley, K. J. McCree, M. E. McDaniel, J. E. Matocha, J. R. Melton, M. G. Merkle, M. H. Milford*, F. R. Miller, J. F. Mills, P. W. Morgan, L. R. Nelson, G. A. Niles, A. B. Onken, R. D. Palmer, F. C. Petr, K. B. Porter, H. J. Price, J. D. Price, J. E. Quisenberry, J. C. Read, K. C. Rhee, J. T. Ritchie, 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, D. T. Smith, G. R. Smith, J. D. Smith, O. D. Smith, R. H. Smith, J. W. Stansel, R. D. Staten, N. A. Tuleen, F. T. Turner, C. H. M. van Bavel, D. M. Vietor, 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 soils, agricultural chemistry, agricultural development, food science and technology, and crops aim to 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, Remote Sensing 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, P.Phy. 313 or equivalent.

305. 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.

306. 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.

307. 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, P.Phy. 314 or 602.

310. 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 Pl.Pa. 610.

312. 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.

315. 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.

317. 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 1984-85 and alternate years thereafter.)

318. 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.

319. Quantitative Agricultural Remote Sensing. (3-0). Credit 3. Physical basis of remote sensing; vegetation indexes, available sensors, field measurements and quantitative data analysis techniques applied to agricultural management and research. Prerequisite: P.Phy. 313 or approval of instructor.

320. 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.

321. 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.

322. 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. 440, 445; Ag.En. 410; Met. 465; P.Phy. 314 or equivalent.

324. 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.

326. 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.

327. Soil Fertility Relationships. (3-0). Credit 3. Behavior of nitrogen, phosphorus 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; P.Phy. 314.

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 F.S.T. 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; Gen. 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; Gen. 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: P.Phy. 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 STATISTICS

P. F. Dahm, R. J. Freund, C. E. Gates, J. D. Hart, A. I. Hillis, R. R. Hocking, O. C. Jenkins, M. T. Longnecker, J. H. Matis, H. J. Newton, E. Parzen, L. J. Ringer*, R. L. Sielken, Jr., L. A. Smith, W. B. Smith (Head), T. E. Wehrly

*Graduate Advisor

The Department of Statistics offers a graduate program, leading to the degrees of master of science or doctor of philosophy. The department also 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. degree (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: 603, 604, 615, 617, 618, 621, 622, 625, 626, 629, 632, 634, 635, 636. 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: C.S. 201; Stat. 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.

622. Advanced Topics in Statistical Methodology. (3-0). Credit 3. Topics in statistical methodology not provided for in other courses and readings of current topics in statistical methodology published in leading statistical journals. Prerequisites: Stat. 606, 608, 612.

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: I.En. 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.

629. Mathematical Programming II. (3-0). Credit 3. Theory, applications and algorithms for integer and mixed integer-continuous variable linear programming problems. Branch-and-bound, implicit enumeration and cutting plane algorithms. Prerequisite: Stat. 628 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, 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. 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. 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 4. 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.

690. Theory of Statistical Research. (3-0). Credit 3. An indoctrination of graduate students into the theoretical and methodological principles of conducting original research in the science of statistics. Outline of guidelines common to all M.S. and Ph.D. research topics but illustrated by and oriented towards the specific research topics of students attending the section of the course. May be repeated for credit. Prerequisite: Graduate classification in the Department of Statistics.

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)

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 Graduate College of Texas A&M University well in advance of the time that the student expects to enroll in the course. Prerequisites: Written permission of the chairman of the student's Advisory Committee, the head of the student's major department, the dean of the Graduate College of 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.

DEPARTMENT OF URBAN AND REGIONAL PLANNING

R. S. Cornish, J. de Jong, R. G. Echols, J. H. Hinojosa, D. L. Pugh*, W. G. Roeseler, V. G. Stover, D. A. Sweeney* (Interim Head)

*Graduate Advisor

The graduate program in the Department of Urban and Regional Planning serves two distinct purposes: to provide the planning profession in Texas with competent personnel in government and private industry through the master of urban planning degree program and to develop high level researchers and policy analysts through the doctor of philosophy degree program in urban and regional science.

Candidates for both 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 architecture, education, engineering, 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 C.E. 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.

621. Concepts of Development Planning in Latin America. (2-3). Credit 3. Literature and programs of development planning in Latin American countries; comparison and evaluation of programs; relevance of development planning in U.S. to Latin America; applicability of planning concepts and programs in developing countries to U.S.

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.

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.

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.

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.

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 C.E. 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 C.E. 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 C.E. 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.

691. Research. Credit 1 or more each semester. Ph.D. research and dissertation.

DEPARTMENT OF VETERINARY ANATOMY

B. V. Beaver, G. R. Bratton (Head), D. L. Busbee, T. Caceci, W. E. Haensly, M. A. Herron, T. R. Irvin, W. R. Klemm, N. H. McArthur, J. E. Martin, M. J. Shively, R. F. Sis, 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 and histology.

The department offers advanced study towards degrees in veterinary anatomy and administers interdisciplinary programs leading to a Ph.D. in veterinary medical sciences. 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 and 6) neuroscience and behavior.

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 students are expected to demonstrate proficiency in or to complete V.A. 601 (gross anatomy) and V.A. 602 (histology). Additional course work or proficiency is recommended in the following areas: cytology/ultrastructure, genetics, biochemistry, pathology, physiology, statistics/computer usage.

(V.A.)

601. Anatomy. (2-6). Credit 4 each semester. Topographical dissection of one of the following domestic animals: horse, ox, dog or cat. Prerequisite: V.A. 202 or 902 or 305 or equivalent. May be repeated for credit.

602. Histology. (2-6). Credit 4. Microscopic structure of anatomical systems of domestic animals. Work arranged for needs of student and in accordance with previous training. Prerequisite: Basic courses in morphology.

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.

609. Anatomy of Reproductive Systems. (2-6). Credit 4. Gross and microscopic anatomy of the reproductive systems of domestic animals. Prerequisite: V.A. 202 or 901 or 601 or 602 or equivalent. (Offered in 1984 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: V.A. 601 and 602 or approval of instructor. (Offered in 1985 and in alternate years thereafter.)

681. Seminar. (1-0). Credit 1. Review and discussion of current scientific work in anatomy and related subjects.

685. Problems. Credit 1 to 4 each semester. Problems in either gross or microscopic anatomy along lines chosen by 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.

DEPARTMENT OF VETERINARY LARGE ANIMAL MEDICINE AND SURGERY

J. A. Auer, J. M. Bowen, C. L. Boyd, R. G. Elmore, J. R. Joyce, W. C. McMullan, R. J. Martens (Interim Head), E. L. Morris, T. S. Taylor, M. F. Young

(V.L.A.M.)

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. 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. 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. Prerequisite: D.V.M. degree. May be repeated for credit.

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. Prerequisite: D.V.M. degree. May be repeated for credit.

630. Veterinary Diagnostics. Credit 1 to 3. Advanced training in arts and science of diagnosis. Clinical and theoretical diagnostic models used for application of procedures which can be expected to yield accurate diagnoses. The logic of diagnosis is emphasized through rational application of facts disclosed by examination techniques and critically selected laboratory procedures. Prerequisite: D.V.M. degree. May be repeated for credit.

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.

689. Special Topics in . . . Credit 1 to 4. Special topics in an identified area of large 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 VETERINARY MICROBIOLOGY AND PARASITOLOGY

R. R. Bell, T. M. Craig, J. M. Cummins, G. S. Elissalde, A. K. Eugster, J. E. Grimes, F. C. Heck, D. H. Lewis, C. W. Livingston, Jr., R. W. Loan, S.McConnell, S. A. Naqi, B. Panigrahy, G. C. Shelton, R. B. Simpson, J. P. Smith, Jr., I. R. Tizard* (Head), G. G. Wagner*, J. D. Williams

*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, avian diseases and aquatic animal medicine.

The department requires no foreign language for the Ph.D. degree program; however, language requirements for the individual student will be determined by the student's Advisory Committee.

VETERINARY MICROBIOLOGY
(V.Mi.)

643. Pathogenic Bacteriology. (3-4). Credit 4. Pathogenic microorganisms, 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: V.Mi. 405 or equivalent.

646. Avian Virus Diseases. (3-3). Credit 4. Viral diseases of poultry; methods of isolation and identification of causative agents. Practice consists of conducting postmortem examinations and diagnostic procedures on naturally and experimentally infected birds. Prerequisite: D.V.M. degree or approval of instructor.

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: V.Mi. 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.

653. Diagnostic Virology. (2-4). Credit 4. Essential techniques for isolation and characterization of the many viruses used in a diagnostic virology laboratory. Methods for rapid diagnosis. Prerequisites: V.Mi. 647 or the equivalent and approval of instructor.

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; V.Mi. 647 or equivalent.

655. Anaerobic Bacteriology. (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 V.Mi. 643 or its equivalent.

660. Diseases of Marine Invertebrates. (4-0). Credit 4. Response of invertebrates to noninfectious and infectious agents. Subject oriented and phylogenetic within each category. Prerequisites: Twelve hours of biological science including at least three hours of histology or microtechniques and approval of instructor.

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 to cancer. Prerequisites: V.Mi. 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
(V.Par.)

601. Parasitology. (3-3). Credit 4. Important helminth parasites of domestic and laboratory animals; their identification, distribution and life history. Prerequisite: V.Par. 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: V.Par. 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: V.Par. 484 or Biol. 108 or 438 or Ento. 208 or equivalent.

685. Problems. Credit 1 to 4 each semester. Special problems concerned with parasites of domestic animals or poultry. Prerequisites: V.Par. 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. T. Boyce, R. W. Boyce, C. H. Bridges, J. F. Edwards, R. A. Green, K. R. Pierce* (Head), W. K. Read, R. W. Storts, P. C. Stromberg, J. W. Templeton, J. E. Womack, A. M.-T. Wu

*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.

(V.Pat.)

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 equivalent.

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. Nutritional and Metabolic Diseases. (3-3). Credit 4. Spontaneous and experimental diseases caused either by deficiencies, excesses or imbalances of specific nutrients or by regulatory disturbances of metabolism in laboratory or domestic animals. Prerequisites: Bich. 411 or 604 and V.A. 903 or Biol. 343.

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 V.Pat. 641. Disease manifestations in special organs and tissues and interrelations of pathologic processes in individual and functionally related organs. Prerequisite: V.Pat. 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: V.M.Id. 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., 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, W. L. Jenkins, D. H. Jones, H. L. Kim, D. C. Kraemer, J. D. McCrady* (Head), A. A. Price, L. D. Rowe, S. H. Safe, S. W. J. Seager, P. R. Vulliet, D. O. Wiersig, 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.

(V.P.P.)

601, 602. Physiology. (3-3). Credit 4 each semester. Recent phases of physiology, modern experimental methods. Work arranged to suit needs of student and in harmony with previous training. Prerequisite: Basic courses in morphology, organic chemistry and physiology.

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: V.P.P. 601 or equivalent; basic statistics course.

608. Systems Pharmacology. (3-3). Credit 4. Effects of drugs on the major organ systems of animals. Prerequisite: V.P.P. 607.

613. Cardiovascular Physiology. (3-3). Credit 4. Cardiovascular physiology using highly specialized techniques and equipment. Prerequisite: V.P.P. 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: V.P.P. 601 or equivalent.

615. Physiology of the Kidney and Body Fluids. (3-0). Credit 3. Kidney and body fluids. Prerequisite: V.P.P. 601 or equivalent.

616. Neurophysiology. (3-0). Credit 3. Physiology of nervous system. Prerequisite: V.P.P. 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: V.P.P. 601 and 602 or equivalent.

619. Molecular Endocrinology. (3-0). Credit 3. Structure-function relationships of hormones, their receptors and biologic activities. Prerequisites: V.P.P. 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, V.P.P. 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 V.P.P. 323 or equivalent, N.E. 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: E.E. 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; V.P.P. 601 or equivalent.

628. Toxicity Testing Concepts. (1-6). Credit 3. Toxicity testing for compliance with federal drug and chemical laws. Prerequisite: V.P.P. 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: V.P.P. 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; V.P.P. 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: V.P.P. 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: V.P.P. 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, W. F. McCulloch, D. N. McMurray, T. D. Phillips, L. H. Russell, Jr.

*Graduate Advisor

Veterinary public health is that part of public health which uses professional veterinary skills, knowledge and resources for the protection and improvement 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.
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 and feed protection** 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) **humane sciences** emphasizing the scholarly interdisciplinary elucidation of people-animal relationships; f) **laboratory animal medicine** emphasizing the study of and provision for breeding, maintenance, and disease preventive procedures involving individual animals and animal colonies used in research; g) **preventive medicine** emphasizing methods to protect and improve human and animal health through development of new veterinary knowledge to defend populations against disease; h) **public health practice** involving the protection and improvement of the health of people and animals by environmental, occupational and human health programs; i) **urban issues** emphasizing the utilization of veterinary knowledge and services for the promotion and protection of human health in urban influenced environments.

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.

(V.P.H.)

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 and analytical epidemiologic methods in the investigation of diseases of contemporary interest. Prerequisite: Graduate classification.

618. Food Toxicology. (3-0). Credit 3. Potential toxicity and other public health implications of various foods, food components, food processing and storage, chemical and microbial contaminants, and naturally occurring toxic factors 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: V.P.H. 618.

632. Public Health Concepts. (3-0). Credit 3. History, organization and administration of local, state, national and international health agencies; development of public health education; concepts of health and disease; introduction to relationships of selected human and animal diseases. Prerequisite: Graduate classification.

633. Animal Diseases in Comparative Medicine. (3-0). Credit 3. Selected diseases transmitted between animals and humans; transmission, prevention, control and use of animal models of human 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

D. K. Chester, E. W. Ellett, E. D. Gage, S. M. Hartsfield, M. R. Herron, H. P. Hobson, K. W. Knauer, G. E. Lees, R. F. Playter* (Head), W. J. Roenigk, C. H. Tangner, Jr.

*Graduate Advisor

(V.S.A.M.)

603. Surgery. Credit 1 to 8 each semester. Special surgery of domestic animals. Prerequisite: D.V.M. degree or approval of department head.

630. Veterinary Diagnostics. Credit 1 to 3. Advanced training in arts and science of diagnosis. Clinical and theoretical diagnostic models used for application of procedures which can be expected to yield accurate diagnoses. The logic of diagnosis is emphasized through rational application of facts disclosed by examination techniques and critically selected laboratory procedures. Prerequisite: D.V.M. degree or approval of department head. May be repeated for credit.

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.

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, L. H. Blankenship, W. J. Clark, J. T. Davis, J. R. Dixon, D. B. Fagre, L. J. Folse, Jr., J. R. Gold, W. E. Grant, F. S. Hendricks, J. M. Inglis, W. H. Kiel, Jr., W. G. Klussmann (Head), A. M. Landry, Jr., A. L. Lawrence, T. L. Linton, J. D. McEachran, W. H. Neill, S. M. Ray, E. H. Robinson, D. J. Schmidly, M. J. Shult, N. J. Silvy, R. D. Slack, R. K. Strawn, W. G. Swank, L. W. Varner, D. A. Wade, M. W. Weller

*Graduate Advisor

Graduate programs leading to master of agriculture, master of science and doctor of philosophy degrees are designed to prepare a graduate for secondary school, college or university teaching, research, fisheries and wildlife management, vertebrate biology and systematics, conservation of renewable resources and ecological impact assessment.

Faculty in this department are especially qualified to direct graduate research in (1) ecology, systematics and behavior of vertebrates; (2) wildlife and fisheries management; (3) aquaculture; (4) limnology and; (5) ecological impact assessment. Facilities are available at Texas A&M University at Galveston and through cooperative arrangements with the Texas Parks and Wildlife Department for students to work on problems basic to the management of both game and nongame species of wildlife and to pursue basic investigations in both freshwater and saltwater fisheries. The department has a research and reference collection of some 150,000 fish, 60,000 amphibians and reptiles, 11,000 birds, 37,000 mammals, and can secure additional materials on loan from other institutions for use in distributional and taxonomic studies.

The Caesar Kleberg Research Program in wildlife ecology is administered in the department, and ecological research is sponsored by this program. Freshwater and marine environments for fisheries teaching and research programs are available near the campus and at Galveston. The department has an aquaculture facility (laboratory and ponds) devoted to teaching and research on production of fish and invertebrate organisms for food and sport fishing. 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 department has no standard requirements for proficiency in foreign languages. Any requirements for foreign languages are set by the student's Advisory Committee. Decisions regarding entry into the graduate program will be made by the following deadlines: fall or summer entry, January 15; fall or spring entry, June 15; spring entry, October 1. Applications and all supporting documents must be received by the Office of Admissions at least 30 days prior to these notification dates.

(W.F.S.)

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: Gen. 603, W.F.S. 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: W.F.S. 315.

07. 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: W.F.S. 402 or equivalent experience in ornithology.

08. 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.

09. 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.

10. 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.

11. 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.

13. 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: W.F.S. 311 or approval of instructor.

14. 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.

15. 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.

16. 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.

18. 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: W.F.S. 311; Math. 230; Stat. 651; or approval of instructor.

19. 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: W.F.S. 410 or equivalent; Stat. 651.

20. Vertebrate Ethology. (3-2). Credit 4. Phylogenetic evolution of behavior; the behavior patterns that animals exhibit for functioning in their environments; problems of everyday activities; social organization; agonistic behavior; territoriality and population integration; reproductive behavior; predator-prey relations; domestication.

21. 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: W.F.S. 422 and 620 or equivalent courses in ethology.

22. 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: W.F.S. 403 or equivalent.

624. Dynamics of Wild Animal Populations. (2-3). Credit 3. Principles, models and meth ods for analysis of population dynamics of wild animals; analysis of contemporary research em phasizing theory and its uses in evaluation and management of wild animal populations Laboratory emphasizes mathematical, statistical and computer modeling of population phenom ena. 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 c community structure with major emphasis at or above the organismic level of organization; nec Darwinian theory compared with alternative evolutionary hypotheses; evolution of vertebrates i relation to neo-Darwinian and other hypotheses. Prerequisite: W.F.S. 603, Gen. 625 or approval c instructor.

628. Wetland Ecology. (2-3). Credit 3. Wetlands as ecological systems that are prime habitat for wildlife and fish; geomorphology, hydrology, limnology, plant and animal communities and human use and management. Prerequisite: W.F.S. 403 or R.S. 316 or 417 or Biol. 459 c equivalent.

629. Collection Management. (2-3). Credit 3. Collection and maintenance of biological ma terials for use in teaching, research and display; procedures, physical storage techniques, elec tronic 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 infor mation leading the use of museums, nature centers, refuges, zoos and other outdoor interpretiv facilities as teaching resources. Short term and extended field trips.

681. Seminar. (1-0). Credit 1 each semester. Important current developments in wildlife c fisheries fields with special reference to literature.

684. Professional Internship. Credit 1 to 4 each semester. On-the-job training in fields c wildlife and fisheries sciences. Prerequisite: Graduate classification in wildlife and fisherie sciences.

685. Problems. Credit 2 to 6 each semester. Individual study and research on selected prob lem approved by instructor and graduate advisor. Credit adjusted in accordance with require ments 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 b repeated for credit.

691. Research. Credit 1 or more each semester. Original research on selected wildlife prob lem to be used in thesis or dissertation.

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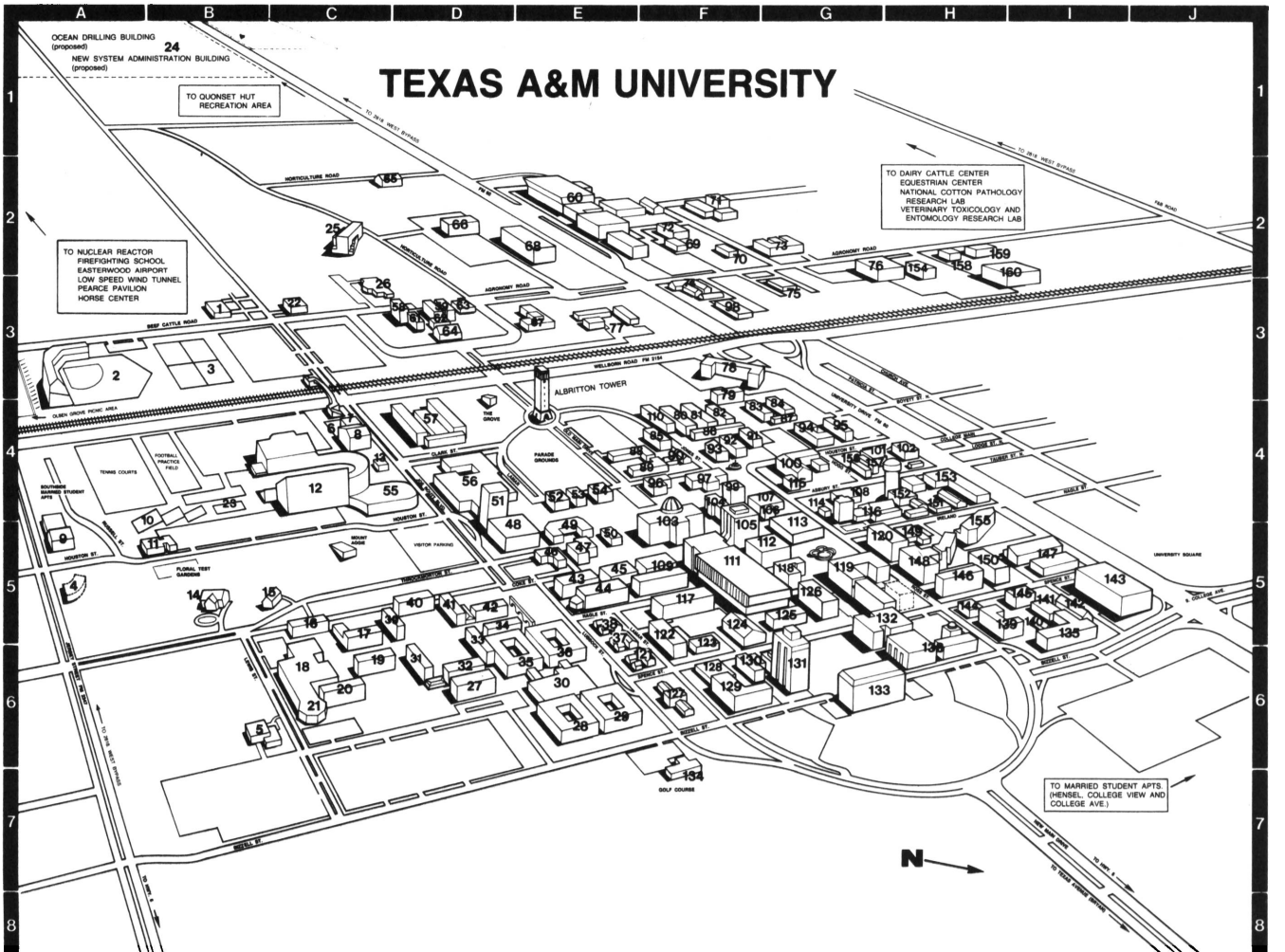
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145 Bituminous Lab (I-5)
52 Bizzell Hall (E-4)
155 Blocker Building (H-4)
104 Bolton Hall (F-4)
33 Briggs Hall-Dorm 3 (D-5)
57 Cain Athletic Hall (D-4)
67 Cater-Mattil Hall (E-3)
(Food Protein R&D Center)
119 Chemistry Building (G-5)
139 Civil Engineering Building (I-5)
4 Clayton Williams, Jr. Center (A-5)
(proposed)
110 Clements Hall (F-4)
54 Coke Building (E-4)
30 Commons (E-6)
128 Computing Services Center (F-6)
(Data Processing Center)
140 Concrete Materials Lab (I-5)
108 Construction Shop and Grounds
Maintenance Building (G-4)
123 Creamery (F-6)
84 Crocker Hall (G-3)
147 Cyclotron (I-5)
79 Davis-Gary Hall (F-3)
8 DeWare Field House (C-4)
146 Doherty Building (H-5)
7 Downs Natatorium (C-4)
18 Duncan Dining Hall (C-6)
36 Dunn Hall (E-6)
126 Engineering Building (G-5)
135 Engineering Laboratory Center (I-5)
150 Engineering/Physics Building (H-5)
(under construction)
114 English Annex (G-4)
74 Entomology Research Lab (F-2)
153 Facilities Building (H-4)
106 Fermier Hall (G-4)
38 Floriculture Greenhouses (E-6)
160 Food Services Commissary (I-2)
121 Forestry Greenhouses (F-6)
127 Forest Science Building (F-6)
75 Forest Science Lab (G-3)
71 Foundation Seed Service (F-2)
41 Fountain Hall-Dorm 4 (D-5)
80 Fowler Hall (F-4)
118 Francis Hall (G-5)
32 Gainer Hall-Dorm 5 (D-6)
134 Golf Clubhouse (F-7)
53 Goodwin Hall (E-4)
55 G. Rollie White Coliseum (C-5)
106 Grounds Maintenance Building (G-4)
92 Haas Hall (F-4)
148 Halbouty Geosciences Building (H-5)
39 Harrell Hall-Dorm 8 (D-5)
112 Harrington Education Center-Classroom (F-5)
105 Harrington Education Center-Office (F-4)
20 Harrington Hall-Dorm 11 (C-6)
49 Hart Hall (E-5)
107 Heaton Hall (Admissions and Records) (G-4)
44 Heidenfels Hall (E-5)
85 Henderson Hall (F-4)
122 Herman Heep Building (F-6)
144 Highway Research Center (H-5)
156 Hobby Hall (G-4)
25 Horticulture/Forest Science Building (C-2)
63 Horticulture Greenhouses (D-3)
101 Hotard Hall (G-4)
86 Hughes Hall (F-4)
142 Hydromechanics Lab (I-5)
81 Keathley Hall (F-4)
42 Kiest Hall-Dorm 2 (D-5)
58 Kleberg Animal and Food Sciences Center (D-3)
29 Krueger Hall (E-6)
12 Kyle Field (C-4)
70 Laboratory Animal Resources Building (F-2)
40 Lacy Hall-Dorm 6 (D-5)
138 Langford Architecture Center (H-6)
88 Law Hall (F-4)
99 Legett Hall (F-4)
31 Leonard Hall-Dorm 7 (D-6)
5 Lindsey Building (B-6)
(University Press)
93 McFadden Hall (F-4)
87 McInnis Hall (G-4)
141 McNew Engineering Lab (I-5)
26 Meat Science and Technology Center (C-3)
66 Medical Sciences Building (D-2)
68 Medical Sciences Library (E-2)
(under construction)
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)
131 Oceanography and Meteorology Building (G-6)
2 Olsen Baseball Field (A-3)
124 Pavilion, The (F-5)
3 Penberthy Intramural Complex (B-3)
151 Physical Plant Building E (H-4)
159 Physical Plant/Grounds Maintenance Facility (H-2)
47 Physics Building (E-5)
117 Plant Sciences Building (F-5)
61 Pomology Lab (D-3)
102 Post Office (H-4)
14 President's Home (B-5)
149 Printing Center (H-4)
76 Purchasing and Stores (G-2)
89 Puryear Hall (F-4)
120 Reed McDonald Building (H-5)
124 Registration Center (The Pavilion) (F-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-5)
59 Soil and Crop Sciences-Entomology Center (D-3)
91 Special Services Building (F-4)
34 Spence Hall-Dorm 1 (D-5)
111 Sterling C. Evans Library (F-5)
133 System Administration Building (G-6)
129 Teague Research Center (F-6)
24 Texas A&M University Research Park (A-1)
72 Texas Veterinary Medical Diagnostic Lab (F-2)
48 Theatre Complex (D-5)
113 Thompson Hall (G-5)
(Mechanical Engineering Shops)
23 Track/Field Event Area (B-4)
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)
9 University Police (A-5)
78 USDA Building (F-3)
16 Utay Hall-Dorm 12 (C-5)
116 Utilities Plant (G-4)
22 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-6)
19 Whiteley Hall-Dorm 9 (C-6)
6 Wofford Cain Pool (C-4)
62 Wool and Mohair Lab (D-3)
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 Clayton Williams, Jr. Center (A-5)
(proposed)
5 Lindsey Building (B-6)
(University Press)
6 Wofford Cain Pool (C-4)
7 Downs Natatorium (C-4)
8 DeWare Field House (C-4)
9 University Police (A-5)
10 Smith Varsity Tennis Courts (B-5)
11 Moore Communications Center (B-5)
(Television and Radio Stations)
12 Kyle Field (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-6)
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 Utilities Plant, Satellite (C-3)
23 Track/Field Event Area (B-4)
24 Texas A&M University Research Park (A-1)
25 Horticulture/Forest Science Building (C-2)
26 Meat Science and Technology Center (C-3)
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 (E-6)
36 Dunn Hall (E-6)
37 Beasley Lab (E-6)
38 Floriculture Greenhouses (E-6)
39 Harrell Hall-Dorm 8 (D-5)
40 Lacy Hall-Dorm 6 (D-5)
41 Fountain Hall-Dorm 4 (D-5)
42 Kiest Hall-Dorm 2 (D-5)
43 Agronomy Building (E-5)
44 Heidenfels Hall (E-5)
45 Analytical Services Building (E-5)
46 Military Sciences Building (Trigon) (E-5)
47 Physics Building (E-5)
48 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-5)
56 Memorial Student Center (D-4)
57 Cain Athletic Hall (D-4)
58 Kleberg Animal and Food Sciences Center (D-3)
59 Soil and Crop Sciences-Entomology Center (D-3)
60 Veterinary Medicine Complex (E-2)
61 Pomology Lab (D-3)
62 Wool and Mohair Lab (D-3)
63 Horticulture Greenhouses (D-3)
64 Anaplasmosis Lab (D-3)
65 Adriance Lab (D-2)
66 Medical Sciences Building (D-2)
67 Cater-Mattil Hall (E-3)
(Food Protein R&D Center)
68 Medical Sciences Library (E-2)
(under construction)
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-3)
74 Entomology Research Lab (F-2)
75 Forest Science Lab (G-2)
76 Purchasing and Stores (G-2)
77 Agricultural Engineering Shops (F-3)
78 USDA Building (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 (F-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)
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)
(Mechanical Engineering Shops)
114 English Annex (G-4)
115 Milner Hall (G-4)
116 Utilities Plant (G-4)
117 Plant Sciences Building (F-5)
118 Francis Hall (G-5)
119 Chemistry Building (G-5)
120 Reed McDonald Building (H-5)
121 Forestry Greenhouses (F-6)
122 Herman Heep Building (F-6)
123 Creamery (F-6)
124 Pavilion, The (F-5)
125 Agriculture Building (G-5)
126 Engineering Building (G-5)
127 Forest Science Building (F-6)
128 Computing Services Center (F-6)
(Data Processing Center)
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 Engineering Laboratory Center (I-5)
138 Langford Architecture Center (H-6)
139 Civil Engineering Building (I-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 Highway Research Center (H-5)
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146 Doherty Building (H-5)
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153 Facilities Building (H-4)
154 Transportation Center (H-2)
155 Blocker Building (H-4)
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)

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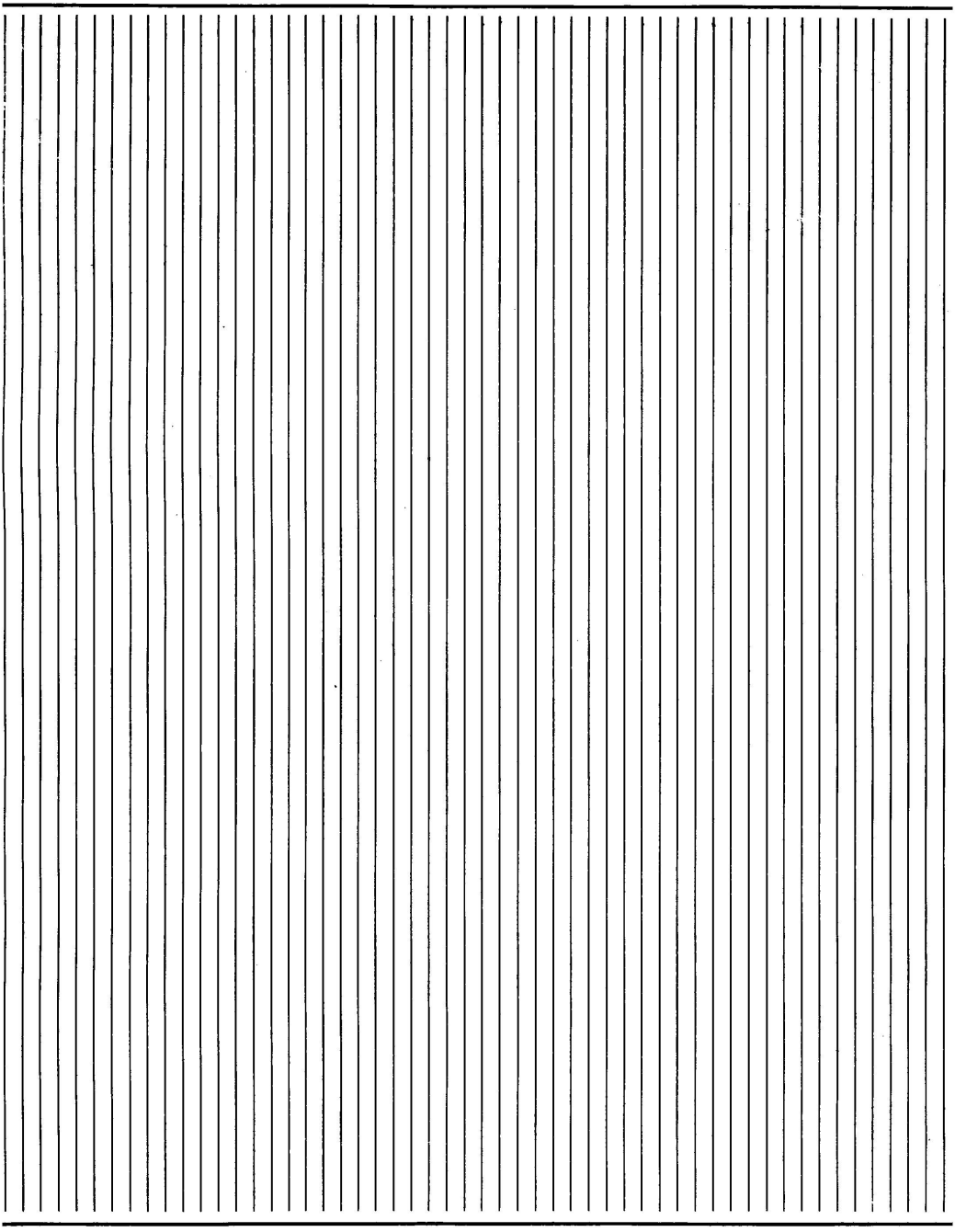

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